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ARCHIVES OF OTOLARYNGOLOGY

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POSTOPERATIVE SINUS THROMBOSIS*

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VIENNA, AUSTRIA

In this paper, I shall describe those cases in which the typical symptoms of sinus thrombosis appear after operative intervention in the middle ear and mastoid; no attention, however, will be given to the question of whether the sinus thrombosis occurred because there was a simple temporal relation or because there was an interdependence of cause and effect.

Of 154 cases of sinus thrombosis in which operation was performed in Alexander's [1] department, twenty-two were of postoperative sinus thrombosis. In 13.9 per cent of the cases the sinus thrombosis was diagnosed after intervention on the mastoid, that is, the middle ear, while in 86.1 per cent of the cases (the greatest majority) the right diagnosis had been made before the operative procedure.

When these cases are grouped according to the nature of the underlying otitis, one finds that in twelve cases the condition was due to acute otitis and in ten to chronic otitis. Thus, acute and chronic otitis show no material difference in the frequency of postoperative sinus thrombosis. This is also true concerning the danger from this development. In eleven, or 50 per cent, of these twenty-two cases death occurred. Six of the eleven patients had chronic otitis and five had acute otitis. It should be noted that the mortality in these cases of postoperative sinus thrombosis is high, especially as compared with the mortality in all cases of sinus thrombosis in which operation was performed in the department. In ninety-six such cases, which also included cases in his private practice, in which operation was performed by the same methods, Alexander (1912) recorded a mortality of 16 per cent, while in clinic cases Alexander and Theimer [2] (1908) found a mortality of 22 per cent. To these, Fruehwald and Brunner were able to add reports of fifty-eight clinic cases, in which operation had been performed in the manner suggested by Alexander. Thus, in a total of 154 cases of otogenic sinus thrombosis, death occurred in 22 per cent and recovery in 78 per cent. The mortality in postoperative sinus thrombosis, therefore, is more than twice as high as that in all

* Submitted for publication, May 6, 1929.

* Translated by Dr. J. E. Skaff, St. Louis.

1. Alexander: Wien. med. Wchnschr., 1923, vol. 51.

2. Theimer: Ueber die Methode der Venenausschaltung bei otitischer Sinusthrombus und Pyämie, Monatschr. f. Ohrenh., 1908, p. 527.

other cases of sinus thrombosis. Although the number of cases of postoperative sinus thrombosis that I have observed is small, this higher mortality figure must be taken into consideration in computing the total mortality figure. This will be discussed again later in the paper.

The great danger of postoperative sinus thrombosis brings up the question whether it is not possible to avoid this complication. In order to answer this properly, it is necessary to review the cases thoroughly.

POSTOPERATIVE SINUS THROMBOSIS FOLLOWING ACUTE OTITIS

First are the cases of postoperative sinus thrombosis following acute otitis. On account of its completely atypical course, the following case must be excluded from this group:

CASE 1.—A man, aged 63, with sugar and albumin in the urine, and otitis of two weeks' duration, was operated on because of marked depression of the posterior superior canal wall. By antrotomy a normal sinus was exposed. Eighteen days after the antrotomy, the patient returned with fully developed symptoms of meningitis and a temperature of 37.5 C. (99.5 F.). On account of the patient's poor general condition, another operation was out of the question, and he died soon after admission. Autopsy revealed meningitis and sinus thrombosis.

There were eleven other cases in which sinus thrombosis followed acute otitis. In five of these cases, the course was typical. The patients came to operation with a high temperature which either was not changed or else was elevated by the antrotomy. On the day after the operation, the temperature ranged between 39 and 40 C. (102.2 and 104 F.) and was sometimes accompanied by chills. Thus the condition was the same whether the sinus was exposed during the operation, as in three cases, or not. After this rise of temperature, either the typical pyemic temperature appeared immediately or, what occurred more rarely (one case), the temperature first fell by lysis, rose again after three or four days and then assumed the typical septico-pyemic character. If the patients were operated on at this time, there were always found obturating, partly suppurating, partly organized thrombi, which extended far into the bulbus or the jugular vein or near the torcular heropluli (charts 1, 2 and 3). It was possible to cure three of these five patients, while two died. On the basis of the foregoing cases, I cannot confirm the bad prognosis that Deutsch [3] gave for cases of sinus thrombosis occurring after acute otitis in which obturating thrombi are found.

Still another case apparently belongs in this group, which on account of the especially sluggish character of the condition demands attention.

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3. Deutsch: Beitrag zur Klinik und Pathologie der Sinusthrombose, Wien. klin. Wchnschr. **22**:713, 1927.

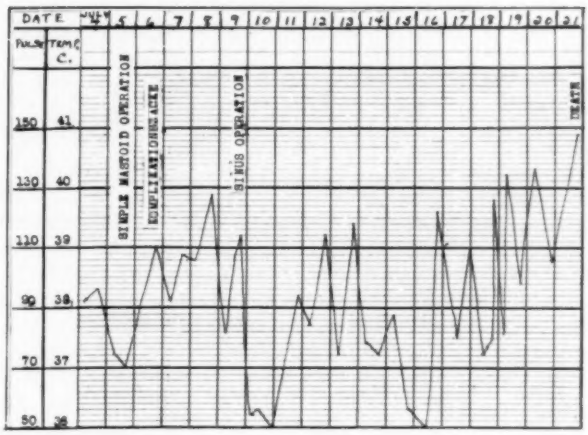

Chart 1.—Record of pulse rate and temperature in a case of latent sinus thrombosis in a woman, aged 36. The patient had recurrent otitis with vomiting and general weakness. A simple mastoidectomy was performed. A normal sinus wall was exposed. The next day, "Komplikationszacke" occurred. Operation was performed on the sinus, and an obturating thrombus was found. Pyemia developed. The patient died.

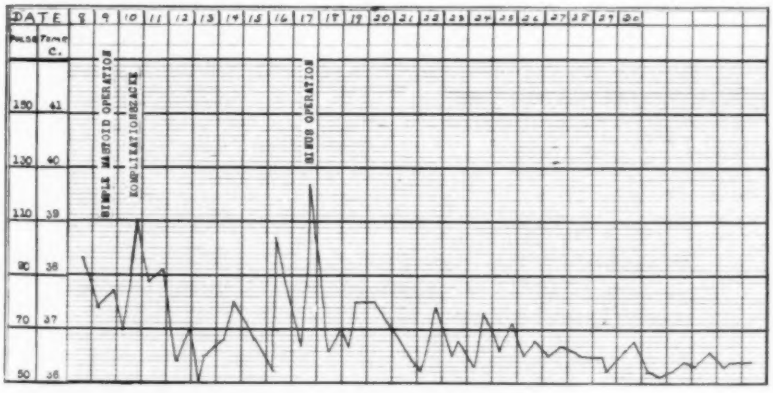

Chart 2.—Record of pulse rate and temperature in a case of latent sinus thrombosis in a woman, aged 32. The patient had acute otitis of three weeks' duration. The temperature remained at 104 F., in spite of three paracenteses. The patient vomited, had headaches and was dizzy; her condition was bad. A simple mastoidectomy was performed. The sinus was not exposed. The next day, "Komplikationszacke" occurred. Seven days after the operation, the patient had fever and a chill. An operation was performed on the sinus, and pus was found. The patient recovered.

Case 2.—M. S., a woman, aged 39, about fourteen days before presentation developed acute otitis on the right side with high fever and pain which at the onset was localized in the mastoid. Paracentesis was refused. Two days later, spontaneous perforation occurred. There was an enormous amount of secretion. The evening temperature was 38.2 C. (100.7 F.). In a few days, a fall in temperature occurred, with profuse discharge. There was subjective improvement. The patient was treated daily in the outpatient clinic, but as the suppuration and pains over the mastoid did not diminish, she entered the hospital. She had suffered for years from apicitis.

On admission to the hospital on Sept. 4, 1912, the patient appeared run down and thin. The temperature was 36.7 C. (98. F.). The right drum membrane was intensely swollen with a perforation in front and below and a profuse, suppurating discharge. Pain was felt on slight pressure over the tip of the mastoid. The left side was normal. Conservative treatment was given.

On September 17, the temperature was 37.6 C. (99.6 F.). The pain over the mastoid was more marked. On September 19, the temperature was 36.6 C. (97.8 F.). Since the previous day, both spontaneously and by pressure, pain had been felt 2 cm. beyond the mastoid process. Otherwise, the condition was

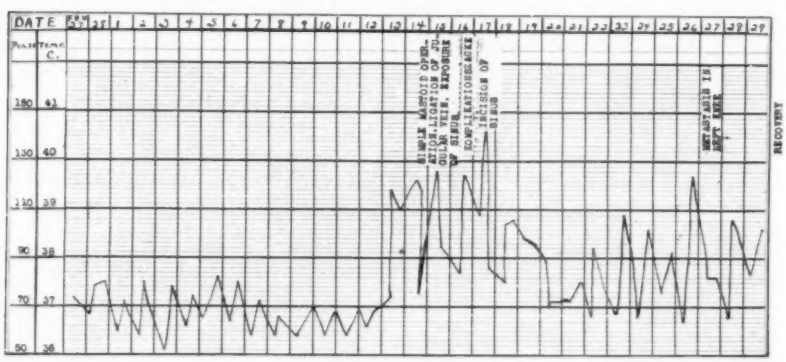

Chart 3.—Record of pulse rate and temperature in a case of latent sinus thrombosis in a woman, aged 43. She had had acute otitis for twenty-seven days with an elevation in temperature to 103.5 F., dizziness on turning, and pains in the occiput and neck. She refused operation until February 15, when a simple mastoidectomy was done. The jugular vein was ligated, and the sinus wall was found normal. The sinus was not incised. The next day, "Komplikationszacke" and chills occurred. The sinus was incised. Pus was found in the sinus. Afterward, many metastases occurred. The patient finally recovered.

the same except for some infiltration over the mastoid. At operation, the mastoid process was found changed into a large abscess cavity, on the inner wall of which a granulating sinus about the size of a bean and covered with a small sequestrum lay free. In the antrum, pus and granulation tissue were found. The sinus was exposed up to the healthy tissue (an area about 1 cm. long). At this time bleeding from the emissarium was stopped by tamponade. The sinus was pulsating and soft. The operative wound was treated by free exposure and drainage.

On September 20, the patient felt pain in the wound. On the 24th, the temperature was 40 C. The patient vomited, but had no chills. On the 26th, the temperature was 36.6, and on the 27th, 39 C. (102.2 F.). She had a sensation of cold but no chills. The wound appeared satisfactory. The sinus was pulsating. The appetite was good. The patient felt no pain. She refused a second operation.

During the entire time the patient had intermittent temperatures, up to 39 C. and down to 36 C. (96.8 F.). Subjectively, she was well on September 30. She had little appetite. The condition of the wound was good. The middle ear had healed. Now and then, she had slight frontal headaches, but no chills or dizziness. For three days the patient had been having severe pain in the muscles of the neck, so that the neck was rigid. The pain sometimes extended into the region behind the right mastoid. Marked pain was felt on pressure over this region as well as on the musculature. There were free side to side motions. At no place could swelling be found. Bacteriologic examination of the blood gave negative results. Lymphocytosis was present. The spleen was enlarged during the entire time. The fundi of the eyes were normal. There was no spontaneous nystagmus. The abdominal and patellar reflexes were slightly increased. No Kernig sign was elicited.

On October 6, operation was performed. The jugular vein, which was only partly filled, was ligated, while the external jugular vein was markedly filled. The sinus was exposed up to the bend. Externally, the sinus appeared normal and felt soft. When the sinus was opened, it was found that it had been completely obliterated by partly organized thrombotic masses. The thrombi were removed downward until blood appeared. The sinus was exposed posteriorly almost to the torcular herophili, until blood gushed forth. Tamponade was done.

On October 7, the temperature was 37.3 C. (99.1 F.). The patient did not have headache and did not vomit. Subjectively, the condition was unchanged. The wound was painful. Complete healing had occurred by January, 1913.

This case shows in an extraordinary way the tendency toward spontaneous healing in sinus thrombosis. In all probability at the first operation, in addition to the periphlebitis, sinus thrombosis was present, the course of the thrombosis corresponded to the slow course of the entire case so that it did not manifest itself on the day immediately following the operation, but five days later. The patient refused the second operation, and a typical pyemic temperature appeared, which, however, was not accompanied by chills. This pyemia lasted for one and a half months. During this time not only were there no metastases, but the wound in the ear and the periphlebitis healed as did the sinus thrombosis to a great extent. The enlarged spleen and the lymphocytosis show that during this time a blood infection was present. In spite of the fact that in this case the natural defensive forces of the body (which, as is known today, are in close relation to the reticulo-endothelial system) were stronger than the invading infection, it was necessary to operate, as one could not tell how long the natural resistance would continue. It is apparent that definite conclusions cannot be drawn from this case, since it was extraordinary and did not follow the general course of sinus thrombosis.

Concerning the pathogenesis, it is clear that in these cases of sinus thrombosis few symptoms appeared before operation ("latent")[4] and

4. I also believe that, only in the rarest cases, does the sinus thrombosis remain really latent. The term latent sinus thrombosis, therefore, means a disease of the sinus which does not produce all the typical symptoms of the usual sinus thrombosis.

the condition was made manifest only by the operative trauma. This manifestation is shown by the fact that immediately after the operation the temperature rises to 39 or 40 C., with or without chills and then either immediately or in a short time develops into the typical pyemic temperature curve. This high temperature immediately after the operation ("Komplikationszacke") is always observed when a latent intracranial complication (an extradural abscess or an abscess of the brain) is made active; hence, it is not characteristic of sinus thrombosis but only of a latent disease of the brain. Only the change from the "Komplikationszacke" to the pyemic temperature curve is characteristic of sinus thrombosis.

This point of view is borne out by the history of the cases. In the course of the acute otitis, there are always high temperature, severe headache, especially frontal, irregularities in the secretion, a sick appearance, pain on pressure behind the mastoid and even chills. All these symptoms were found in the cases reported here; they were not, however, sufficiently appreciated. Therefore, since the first operation was insufficient, the full complex of the symptoms of sinus thrombosis was produced.

The remaining five cases, which will be reported later, are much more complicated.

SINUS THROMBOSIS AFTER OPERATION FOR CHRONIC SUPPURATION

The sinus thrombosis that appears after operation for chronic suppuration presents another picture. In this connection may be mentioned a case in which three days after the removal of a polyp from the middle ear sinus thrombosis became manifest. As the patient had fully developed meningitis when he was brought to the hospital, nothing could be said about the pathogenesis of the intracranial complication.

The facts are clearer in another case.

CASE 3.—F. K., aged 8 years, had diphtheria at the age of 4 and measles at the age of 5. Eight days before admission to the hospital, the child had sharp pains in the right ear and three or four days later, there was a discharge from the ear. Two days before admission, swelling appeared behind this ear. On admission, the child was pale. The left ear was normal. There was a swelling at the right ear which extended to the lower eyelid. A fetid secretion, containing particles of cholesteatoma, came from the ear. The conversational voice could be heard by the right ear at a distance of 1 meter, and by the left at 5.5 meters. The whispered voice could be heard by the right ear at a distance of 10 cm. The Weber test showed lateralization to the right. The Rinne test was negative in the right ear. The Schwabach test of the right ear showed a lengthening in the period of time required for hearing by air and bone conduction. There was no spontaneous nystagmus. The turning test gave normal results.

On July 28, 1916, the supperiosteal abscess was opened. A mastoid fistula was found. Inside, the mastoid was necrotic and boggy. A cholesteatoma about the size of a cherry was found in the antrum. The posterior and middle fossae had

to be connected by removal of the entire softened and pus-laden portion of the pyramid. The sinus was exposed for a distance of 3 cm. It was discolored and covered with spongy granulations. The dura of the midfossa was exposed in an area about the size of a quarter. A radical operation was performed. In the middle ear, granulation tissue and cholesteatoma were found. A plastic procedure was done, and the wound was closed.

After the operation, the condition of the patient was good. There were no complaints or headache. At first, the temperature was slightly elevated; then it became subfebrile, and in several days it was normal. The dressing was changed daily. In the tympanic cavity was spongy granulation tissue which was proliferating luxuriantly.

On August 21, the temperature was 38.7 C. (101.6 F.); this elevation recurred during the next few days. On August 21, headache was also present. The recurring elevations in temperature, the luxuriantly growing granulation tissue, the fatigue and the pale appearance of the child during the next few days made a second intervention necessary. On August 25, the sinus wall was exposed. The dura of the posterior fossa showed a solid, dirty, blue-red covering. When the wall of the sinus was opened, the sinus appeared empty and its lumen narrowed. Jugular ligation was done. The sinus appeared closed off like a sac about 1 cm. behind the upper bend. Below, just above the bulb, were thrombosed masses infiltrated with pus, which were removed until blood gushed forth. On September 20, secondary closure of the wound was done. On October 1, the wound had healed and the patient was discharged.

It is probable that in this case sinus thrombosis had been present since the time of the first operation, because there was "compression thrombosis," first described by Kramm [5] and Passow,[6] and because the condition seldom appears after operation on the bone. I shall not discuss "compression thrombosis," the existence of which was acknowledged by Ruttin,[7] Bondy [8] and Urbantschitsch [9] and denied by Leutert, Haymann [10] and others, but by the term compression thrombosis I mean the following condition observed at operation: near a large perisinus abscess, the sinus for a considerable distance is found free and its cerebral wall macroscopically intact, while, peripherally and centrally from this completely or almost completely blood-free portion of the sinus extends an obturating thrombus. Although I shall not discuss the pathogenesis of this form of sinus thrombosis, I feel that the explanation which Passow (not Kramm) gives for the origin of compression thrombosis is obvious, and I cannot understand Haymann's

5. Kramm: Ztschr. f. Ohrenh., vol. 53.

6. Passow: Passow-Schafer's Beitrag, vol. 3, p. 106.

7. Ruttin: Monatschr. f. Ohrenh., vol. 44, pp. 236 and 303; vol. 53, p. 340; Ueber septische Blutungen bei Sinusthrombose, Acta. Otolaryng. **8**:274, 1925.

8. Bondy: Zur Klinik und Pathologie der otitischen Sinusthrombose, Monatschr. f. Ohrenh. **43**:9, 1909; Zur Frage der Sinusthrombose nach Freilagung des gesunden Sinus, Arch. f. Ohrenh. **85**:216, 1911.

9. Urbantschitsch, E.: Monatschr. f. Ohrenh., vol. 44, pp. 233 and 304.

10. Haymann: Arch. f. Ohrenh., vol. 86, p. 272; Handb. f. Hals-, Nasen- u. Ohrenhkrankh., 1928.

disagreement with the view of Passow, since Passow, as well as Haymann, believes that compression thrombosis originates not only as a consequence of pressure from the side of the perisinus abscess, but as a result of the infection.

With Dr. Fruehwald, I was able to observe a second case of compression thrombosis, which is of interest, since it occurred in a child aged 15 months.

Case 4.—The patient developed bronchitis on Jan. 22, 1928, with a fever of 40.3 C. (104.5 F.). On January 28, the mother observed that the child frequently put its hand to its ear, and cried if the ear was touched. The temperature began to fall by lysis. On February 4, the child was feeble and had lost its appetite; swelling was present behind the ear. During the period between January 28 and February 11, it would frequently cry out in the night. There were no chills. On February 5, paracentesis was done, and pus drained freely. On the 6th and 7th, the temperature was pyemic; there was still a free flow of pus from the left ear and an increase in the swelling behind the ear, with the formation of a distinct depression of the upper posterior canal wall.

On February 8, a subperiosteal abscess was opened. No fistula was found on the surface of the mastoid. The posterior part of the tendon of the sternocleidomastoid muscle was pushed aside and a fistula the size of a cherry seed was exposed; on pressure pus streamed freely from this. Antrotomy was then done. In the mastoid little pus was found; the bone was hyperemic and soft. The cells at the tip were filled with pus. After termination of the antrotomy, no connection was found between the operative cavity and the fistula. The bone lying on the sinus was soft and hyperemic. The fistula was united with the operative cavity; therefore the sinus and the dura of the cerebellum had to be laid free. Granulation tissue was found everywhere. Two incisions made posteriorly were helpful. The sinus was laid free above and below, until the normal part of the sinus wall was exposed. When the sinus was opened, it appeared empty. The cerebral wall of the sinus was smooth, glossy and macroscopically normal. A sound passed into the transverse sinus caused blood to spurt forth from the peripheral end of the sinus; no blood flowed from the central end. Tamponade was done, and the bleeding was controlled. Because the pulse was weak after the operation, the contemplated jugular ligation was not performed. Caffeine was injected. *Streptococcus mucosus* was found in pure culture in the pus. The postoperative course was uneventful; on February 22, the child had improved; the wound in the ear showed granulation, and the patient was placed under the care of a physician for after-treatment. On the twentieth day after the operation, however, the temperature rose to 39.2 C. (102.5 F.), which was followed for a period of six days by a typical pyemic temperature; this condition, however, was attributed by the physician to tonsillitis, although the wound in the ear showed an insignificant tendency toward healing and was filled with necrotic granulation tissue. Then there was a fall of temperature by lysis which, except for temporary rises to 38.7 C. (101.6 F.), lasted for thirty days. On the fifty-eighth day after operation, the temperature suddenly rose to 39.3 C. (102.7 F.); on the following day, it fell to 36.5 C. (97.7 F.). From that time, the temperature rose gradually to 39.3 C. When the child was again examined, signs of diffuse meningitis were found. Operation was immediately performed; the jugular vein was ligated, and the sinus again laid free, unfortunately to no avail. Four days after the second operation, the child died of meningitis.

In case 3, the "Komplikationszacke," occurring immediately after the radical operation and thus showing that there was sinus thrombosis was absent. I have not seen this "Komplikationszacke" in chronic cases. The existence of sinus thrombosis in these cases was more perceptible, since the operative wound showed only slight tendency toward healing, as evidenced by the growing of unhealthy granulation tissue and by the appearance of meningeal symptoms soon after the operation on the bone. The fact that until now the "Komplikationszacke" had not been observed in chronic cases can be explained by the fact that operation is performed more seldom for "latent" sinus thrombosis in chronic cases of otitis than in acute cases, because sinus thrombosis is more easily determined in chronic than in acute cases.

Glancing over the eight cases so far described, one sees that the condition dealt with was always so-called "latent" sinus thrombosis, which was made manifest through operation. In regard to pathogenesis, these cases have nothing to do with postoperative sinus thrombosis, i.e., with sinus thrombosis developing after or caused by the operation. The facts are different in the remaining thirteen cases.

I now come to the clinically important question of whether postoperative sinus thrombosis, i.e., sinus thrombosis following operation on the mastoid is possible. This possibility is acknowledged today by the majority of otologists as long as the condition also exhibits a rare occurrence. Bondy, in particular, characterized postoperative sinus thrombosis by the following signs: no indication of a previously existing sinus thrombosis; the exposure of a normal-appearing sinus wall; a pyemic temperature after a given interval, and thrombosis exactly at the site exposed. Concerning the pathogenesis of this form of sinus thrombosis, Bondy, with Stenger, assumed that exposure of the sinus wall injures the superficial layers of the wall, thus producing a tendency toward the development of sinus thrombosis. Accordingly, accidental exposure is conducive to the development of postoperative sinus thrombosis.

I shall show later in the paper that I cannot entirely agree with this point of view, with which Leichsenring [11] also did not agree. If exposure of the normal sinus wall necessarily causes postoperative sinus thrombosis, this condition should occur much more frequently than it does. However, I do not consider exposure of the sinus wall harmless; I believe that such exposure favors the development of postoperative sinus thrombosis, and that this is especially the case when the sinus is in the anterior position. I believe, however, that other factors are of still greater significance in the development of postoperative thrombosis, as will be proved later in the paper.

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11. Leschke: Sepsis, Spec. Path. u. Therap. inn. Krankh., 1919, vol. 11.

In the material reported here there is only one case which belongs to this category and in which after the operation for acute exacerbation sinus thrombosis appeared. At the operation, the wall of the sinus in its marked anterior position was exposed. Four days after the radical operation, the patient had a temperature of 40.4 C. (104.7 F.) and chills. At the second operation, the exposed sinus wall was found to be thickened; incision of the sinus resulted in profuse bleeding (mural thrombus). In spite of the immediately performed ligation of the jugular vein, the patient died after two days, and autopsy disclosed thrombophlebitis in the left sinus, bronchopneumonic spots in both lungs, a congested spleen and a parenchymatous degeneration of the internal organs.

This case showed all the characteristics of postoperative sinus thrombosis that Bondy has enumerated, and it is noteworthy that in these cases the interval between the operation on the bone and the appearance of the "Komplikationszacke" is not more than from three to five days. Similar cases were described by Hansberg,[12] Popper,[13] Burkner and Uffenorde,[14] Leichsenring,[15] Bondy and others.

Injury of the sinus wall seems to me to be more dangerous than mere exposure; this has been pointed out repeatedly (Koerner).[16] I have seen two cases belonging to this category; both patients had acute otitis which ran its course without any signs of complication. On antrotomy, granulation tissue which had begun to break through the cortex was found in the mastoid process. In both cases the granulations extended to the sinus, the wall of which was diseased and therefore had to be exposed. By the exposure, the sinus wall was injured; as a result, between six and eight hours after antrotomy, chills and a high temperature set in ("Komplikationszacke"), which made necessary an operation on the sinus accompanied by ligation of the jugular vein. In both cases, blood appeared on incision of the sinus; in one case, however, thrombosis of the bulb must have taken place, since the jugular vein was empty. In both cases, the wound healed satisfactorily. It is evident that these were cases of traumatic sinus thrombosis which became manifest in a relatively short interval after antrotomy.

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12. Hansberg: Ztschr. f. Ohrenh., vol. 44.

13. Popper: Postoperative Nekrose der Sinuswand, Monatschr. f. Ohrenh., vol. 59, p. 24.

14. Burkner and Uffenorde: Bericht der Universitätsklinik, Arch. f. Ohrenh. **72**:50, 1907.

15. Leichsenring: Darf man bei Antrotomien die Weichteile primär schliessen? Ztschr. f. Ohrenh., vol. 80, pp. 21 and 213; Die Gefahren der operativen Freilegung des Sinus, ibid. **82**:64, 1922.

16. Koerner and Gruenber: Die otitischen Erkrankugen des Hirnes, 1925.

Thus far, I have demonstrated cases in which injury of the sinus wall played a significant rôle in the development of sinus thrombosis. The cases reported are characteristic in that the sinus thrombosis became manifest as late as one week after the operation on the bone. But such cases are rare. Of thirteen cases only three of this kind were found. Leichsenring's assertion that there are two other factors at the site of the lesion of the sinus wall, namely, the presence of highly virulent germs and stagnation of secretion, therefore seems correct. Concerning the second factor, Leichsenring refers principally to cases in which the sinus was primarily closed or of cases in which the sinus was covered by plastic flaps. I have had no experience with such cases since in Alexander's department the closure of the wound is strictly prohibited when the dura or the sinus is exposed, and since the plastic flaps never cover the sinus. Although according to observation in this department the faulty procedure at operation mentioned by Leichsenring is not necessarily the cause of stagnation of secretion, a highly virulent infection in the wound cavity is sufficient to cause the retention and stagnation of secretion through the increased formation of granulation tissue and pockets and undermining of the edges of the wound. Therefore, my associates and I consider the degree of virulence of the invading organisms as the most important factor in the causation of postoperative sinus thrombosis.

SINUS THROMBOSIS OCCURRING AFTER RADICAL OPERATION

Among the reported cases of sinus thrombosis occurring after radical operations, six which are strongly characterized by their clinical course, belong to this category. These patients came to operation when the condition was in the stage of acute exacerbation. This acute exacerbation is characterized not only by profuse secretion, but by the headache on the affected side and by pains in and behind the mastoid process, by diminution of hearing and frequently also by labyrinthine dizziness. At operation, chronic otitis complicated mainly by cholesteatomas is commonly found. In the first three days after operation, elevations in temperature are often found; the temperature, however, does not rise higher than 38.2 C. (100.7 F.), and then falls to normal or slightly above normal. The retro-auricular wound usually shows a profuse, fetid secretion; the edges of the wound are markedly inflamed or retention pockets of pus are being formed. However, the general condition of the patient is apparently not disturbed. In the six cases reported, ten to sixteen days after the radical operation a high temperature, around 40 C., and chills ("Komplikationszacke") suddenly occurred. A second operation was performed at this time, and I was astonished at the slight involvement of the sinus. In our cases there was either only a slight oozing of blood on incision at first

and then a marked gushing forth of blood (mural thrombus) or an immediate profuse bleeding, which can also occur in a case of mural thrombus. At no time was an obturating thrombus seen in these cases. After operative intervention at the sinus and jugular ligation typical septicopyemic temperatures appear, which can also be associated with the development of metastasis in the lungs, joints and brain. Cases belonging to this category were described by Leichsenring, Grunert and Zeroni,[17] Panse,[18] Sturm and Suckstorff,[19] Freytag[20] and others.

The prognosis in these cases is serious; four of the patients died, while the fate of one is not known, as the patient left the hospital against advice while he had fever. Only one patient, therefore, has been cured.

It was especially brought out that whether or not the sinus is freely exposed by radical operation and whether or not the wall is found normal in case of exposure, the course of the disease is not affected. In two of the six cases reported, the sinus was not exposed by the radical operation. In the remaining four cases the sinus was freely exposed; the wall appeared normal in three cases, while in one, delicate fibrinous deposits were found. The last mentioned case is the one in which a cure was effected. From these statistics one may conclude that exposure of the sinus has a certain influence on the development of postoperative sinus thrombosis, an influence which, however, cannot be of definite significance, since the duration of the development of sinus thrombosis is not greatly altered whether the sinus is exposed or not.

Two cases, in which sinus thrombosis resulted after radical operation without the exposure of the sinus, are reported.

Case 5.—The parents of M. H., a woman, aged 36, were living and well. The patient had eleven brothers and sisters, all of whom died during childhood. In March, 1920, she had grip. Following this, she had headaches, especially in the frontal region, and marked pains in the left ear. On arising she felt dizzy. For several days, both ears had discharged. Since then there had been no complaints referable to the ear. For two months, buzzing had been present in both ears. For several days the patient had had marked headaches, pain in the left ear and dizziness on turning.

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17. Grunert and Zeroni: Jahresbericht der Universitäts-Ohrenklinik zu Halle, Arch. f. Ohrenh., 1900, vol. 49.

18. Panse: Zwei Fälle von Sinusbeteiligung nach Aufmeisselung, Arch. f. Ohrenh. **51**:23, 1901.

19. Sturm and Suckstorff: Beiträge zur Kenntniss der otitischen Erkrankungen des Hirnes, Ztschr. f. Ohrenh. **41**:111, 1902.

20. Freytag: Beitrag zur Casuistik der otitischen Pyämie, Ztschr. f. Ohrenh. **45**:127, 1903.

On presentation, on Oct. 14, 1921, a large perforation was found on the right side in the upper posterior quadrant. The tympanic mucous membrane was inflamed. A little secretion was present. On the left side, peripheral perforation was found in the upper posterior quadrant. The tympanic mucous membrane was inflamed here also. The whispered voice could not be heard on either side. The conversational voice could be heard close to the ear on both sides. The Weber test showed deafness due to disease of the auditory apparatus. The Schwabach test showed that bone conduction and air conduction were prolonged bilaterally. The Rinne test was negative. The ticking of a watch could not be heard through the mastoid process. Horizontal-rotary nystagmus was present on both sides. The Romberg sign was not present. The reaction to the turning test was normal. Aspiration nystagmus was present on the right side.

On the day of presentation, the typical radical operation was performed on the left side; nothing of importance was found. Following this the patient showed a state of constant well-being, except for a profuse fetid discharge from the retro-

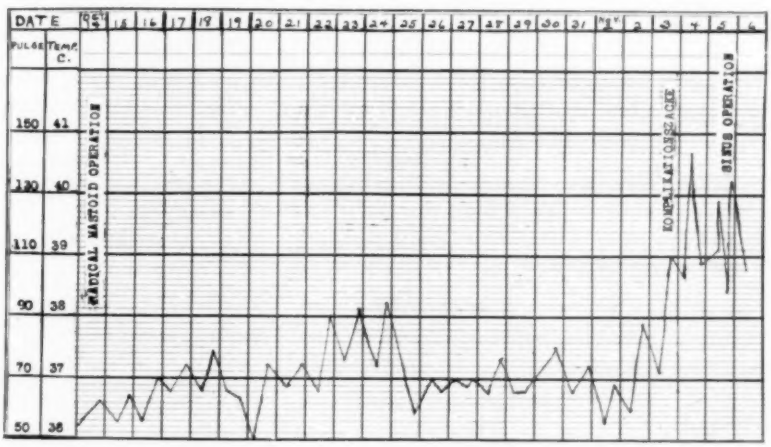

Chart 4 (case 5).—Record of pulse rate and temperature in a case of post-operative sinus thrombosis in a woman, aged 36. An acute exacerbation of chronic otitis occurred, with dizziness on turning. A radical mastoid operation was performed. The sinus was not exposed. Twenty days after the operation, "Komplikationszacke" occurred. Operation was performed on the sinus, and the jugular vein was ligated. A perisinus abscess and a mural thrombus were found. The patient left the hospital without permission.

auricular wound. On November 3, there was a sudden rise of temperature to 40.7 C. (105.2 F.) and a chill in the morning. On November 5, the temperature was 38.9 C. (102 F.), and the patient had difficulty in breathing. Bronchitis was present on both sides. On November 5, the temperature was 39.9 C. (103.8 F.). The patient had a chill in the morning. In the evening, the jugular vein was ligated and the sinus exposed. A perisinus abscess and thickening of the sinus wall were found. On incision, bleeding occurred under slight pressure (mural thrombus). On November 7, the patient showed improvement. No meningeal symptoms were present. The patient left the hospital against advice (chart 4).

Case 6.—K. F., aged 54, married, the parent of five healthy children, in 1911 had a peritonsillar abscess and in 1917, acute otitis on the left side.

Later, there was an intermittent purulent discharge from the ear. The patient had intermittent headaches. For the past fourteen days, the headaches had increased considerably. The pains were localized in the forehead and radiated intermittently to the left and to the right. On turning and then stopping, the patient noticed intermittent dizziness.

On admission to the hospital on Dec. 8, 1924, the right drum membrane was retracted. There was a kidney-shaped perforation in the left posterior quadrant. The left middle ear was partly filled with granulation tissue. There was an intermittent discharge of foul pus. On the right side, the whispered voice could be heard at a distance of + 12 meters; on the left, close to the ear. The Weber test was referred to the right ear. The Schwabach test showed that bone conduction and air conduction were normal bilaterally. The Rinne test was negative bilaterally. The right ear heard c_4 normally, while the length of time the tone was heard by the left ear was somewhat shortened. A watch placed over both mastoids was not heard. Slight horizontal rotary nystagmus to the right was present intermittently, and was not influenced by movements of the head. The Romberg sign was not present. The caloric reaction was normal bilaterally. Examination of the eyes by Dr. Kestenbaum showed the fundi unchanged and no contraction of the visual fields. On March 10, a typical radical operation was performed, which revealed nothing of importance. On March 13, the margins of the wound were inflamed. Burrow compresses were applied and the dressings were frequently changed. Because of the persisting fever, although there were no chills or meningeal or labyrinthine symptoms, the wound was opened again on March 18 for removal of the mastoid tip. The dura of the middle fossa was exposed. Internally, nothing of significance was found. The wound appeared infected. The condition resembled erysipelas. On March 20, a chill occurred for the first time. On the 21st, the patient had persistent chills but no meningeal symptoms. The infection of the wound had practically disappeared. The sinus wall was exposed and was found covered with granulation tissue. It was exposed peripherally until healthy tissue was encountered. In the direction of the bulb the normal sinus wall could not be reached. The sinus was carefully opened and only blood oozed forth (mural thrombus). The bulb was entered with forceps until the blood flowed in a stream. On account of the poor condition of the heart, ligation of the jugular vein was delayed. The chills persisted, and the patient died on March 24. At autopsy, a purulent thrombophlebitis of the sigmoid, cavernous and intercavernous sinuses, an acute splenic tumor, general fatty degeneration and fatty heart (alcoholic), but no metastases were found. I described the petrous bones in this case in case 1 of my paper on "Otogenous (Cavernous) Phlebitis" published in 1925.

That the prognosis in these cases is not always so bad is shown in a case reported by Freytag,[20] in which postoperative sinus thrombosis appeared ten days after the radical operation; for thrombosis operation was not performed. This case was, of course, exceptional. Although the condition healed, much later an operation was performed on the patient, a man, aged 36, for other reasons, and the sinus and the dura of the cerebellum proved to be normal. In regard to spontaneous healing of sinus thrombosis, I was able to observe a similar case in America.

Case 7.—A girl, aged 3 years, had otitis on the right side, accompanied by a high fever (from 39 to 40 C.). After paracentesis, the temperature fell by crisis

to normal. This is usually considered an unfavorable sign in children. A few days later, the patient again had a high temperature and otitis on the left side; paracentesis was done on this side also. Soon after this a depression of the posterior superior canal wall developed on the right side, and antrotomy was performed. Blood oozed from the mastoid but there was no pus; a little granulation tissue was present in the antrum. Because of the patient's high temperature, the sinus was exposed. The wall was found to be normal. After the operation, chills and a pyemic temperature were present. A jugular ligation on the right side was proposed, but the parents would not consent to this operation. About one week after the sinus was exposed, the child suddenly collapsed and became stuporous; her pulse was weak and she was cyanotic. A lung embolus was considered because a pneumonic focus soon developed. The relatives still refused permission for the operation, and for several days the child had chills and a pyemic temperature which rose to high peaks. However, she was finally cured and was able to leave the hospital.

The condition dealt with here was also sinus thrombosis in which spontaneous healing occurred, because the metastasis in the lungs does not fit in with the picture of osteophlebitic pyemia (Koerner). Naturally, one cannot form definite conclusions from these cases.

Two symptoms which seem to be ominous in the six cases reported, should be mentioned; the postoperative appearance of Bell's palsy and hemorrhage from the sinus. In regard to the latter symptom, after operation on the sinus, one sometimes finds a remarkably slow production of thrombus. Ruttin described two such instructive cases. In the six cases reported, two were found in which hemorrhage occurred. In one of these, a hemorrhage of the sinus occurred fifteen days after the operation and could not be stopped, not even by tamponade. The blood oozed through the tuba into the pharynx and was aspired by the patient. Both patients died, and in one autopsy showed only a severe anemia of the inner organs (chart 5). The bleeding from the sinus had therefore caused death. It is known that the fibrin content of the blood is decreased in septicemia of streptococcic and staphylococcic origin (A. Oswald, Paltauf [21] and Leschke). That Urbantschitsch always found a normal or slightly delayed thrombosis in otogenic sinus thrombosis does not contradict the foregoing statement. Also, in the previously mentioned case, the time required for the occurrence of thrombosis was normal.

In addition to the six cases of sinus thrombosis occurring after radical operation, I shall report three cases following acute otitis, which in the main present similar courses.

CASE 8.—A boy, aged 14 years, was operated on for acute mastoiditis following otitis which had been present for a week. In addition to the otitis, the child had headache, dizziness on turning and elevations in temperature up to 37 C. (98.6 F.). During antrotomy, which revealed acute mastoiditis, the normal sinus was exposed

21. Paltauf: Pathologie der Gerinnung, Handb. d. allg. Path. **11**:50, 1912.

in an area about the size of a finger-nail. Four days after the operation, severe infection of the wound occurred, with swelling in the zygomatic region and at the tip of the mastoid, etc. In addition, follicular angina occurred, and finally, fourteen days after the antrotomy, the typical "Komplikationszacke" appeared. The sinus was now covered to a great extent by granulation tissue, but on incision the blood spurted forth. Nevertheless, the boy died six days after the operation on the sinus with the symptoms of meningitis and cavernous phlebitis (edema of the lids, protrusion of the bulb), which were also verified post mortem.

In this case, there was a severe infection of the wound, and this infection must have been intensified because the resistance of the body was lowered by the angina. The similarity of the course of this case to that of the six occurring after chronic otitis and the difference in the course compared with that in latent sinus thrombosis following acute otitis are clear.

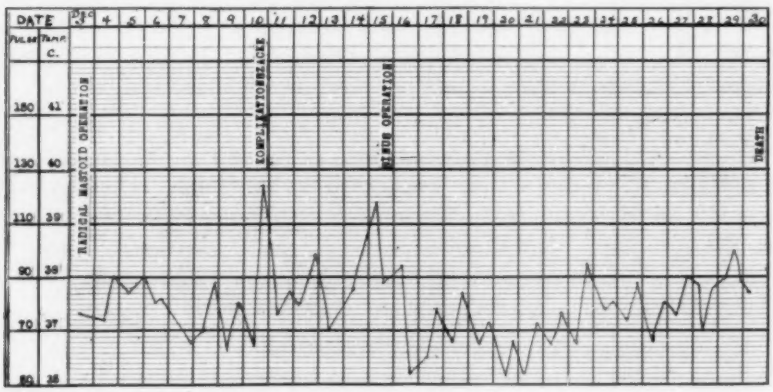

Chart 5.—Record of pulse rate and temperature in a case of postoperative sinus thrombosis in a man, aged 27. There was an acute exacerbation with dizziness on turning. A radical mastoid operation was performed. A cholesteatoma was found. A traumatic lesion of the sinus occurred. Seven days after the operation, "Komplikationszacke" took place. An operation was performed on the sinus. A mural thrombus was found. After the operation, a sinking abscess of the neck was found. Fifteen days after operation, facial paralysis occurred. Another operation was performed on the sinus. Bleeding occurred from the sinus and did not stop. The patient died. Autopsy revealed anaemia gravis viscerum.

Case 9.—O. P., aged 31, on Sept. 23, 1924, after bathing, felt pain in the ears. On September 27, acute otitis was present on the right. Paracentesis was done; a great deal of mucopus was found. The patient had fever; the region over the mastoid was painful and tender.

The patient was admitted to the hospital on September 30. The right side showed sagging of the posterior superior wall and profuse watery suppuration with pulsation. Mastoiditis was present. The temperature was 38.4 C. (101.1 F.).

On October 10, the temperature was 37.9 C. (100.2 F.). On the 11th, operation was performed. On antrotomy, after the first stroke of the chisel, pus under pressure was obtained. There was granulation tissue in the antrum. Abscesses

were present at the beginning of the zygomatic process and at the tip. The tegmen was intact. A perisinus abscess was present. The sinus lay free and was covered with fine granulation tissue. On October 12, the temperature was 38.5 C. (101.3 F.). Pain was present. There was a profuse discharge from the retro-auricular wound. On October 14, the temperature was 37.8 C. (100.2 F.). A profuse discharge was present. The external meatus was dry. On the 18th, the patient had two chills. The temperature at night was 39.9 C., and in the morning, 38.8 C. (101.8 F.). Jugular ligation was performed on the right. The vein was filled with blood. After the dressing was removed, profuse bleeding occurred from the sinus. Tamponade was done. Staphylococcus vaccine was given. On October 19, the temperature was 38.4 C. The patient did not have chills. On the 20th, the outer dressing was changed. The temperature was 39.3 C. (102.7 F.). The patient did not have chills. Staphylococcus vaccine was given. On October 21, the morning temperature was 39.5 C. (103.1 F.) and the evening temperature, 36.6 C. (97.8 F.). On this date the patient did not have chills. On the 22nd, he had a chill. The temperature was 40 C. The dressing was changed. No hemorrhage occurred. On the 23rd, the temperature was 39.3 C. (102.7 F.). No chill occurred. Nystagmus of the first degree was present on both sides. The eyegrounds were normal. The evening temperature was 39.6 C. (103.2 F.). On the 24th, the morning temperature was 38.1 C. (100.5 F.). The pulse rate was 120. On the 26th, the temperature was 40.2 C. (104.3 F.). The patient had a chill. Transfusion of 100 cc. of blood was given. On the 27th, the temperature ranged from 39.4 to 40.2 C. A colloidal suspension of silver was given. On the 28th, the temperature was 39.6 C. Death occurred on October 29. At autopsy, no thrombosis or meningitis was found. Multiple infarcts were present in both lungs. A septic tumor of the spleen, parenchymatous degeneration of the liver and kidney of severe degree and severe general icterus were found.

In this case too, there was doubtless a severe infection of the wound, as only in this way can the appearance of sepsis with continual high fever be explained. That sepsis, in such a short time, caused an intoxication of the body with metastasis is not clinically evident. Unfortunately, the petrous bones were not studied microscopically, so that the primary origin of the sepsis is not known.

One more case may be added to this group, the exact cause of which cannot be stated, because when the patient was brought to the hospital, he already presented the fully developed picture of sinus thrombosis. Two and a half months after a radical operation for an acute exacerbation, vertigo, fever and vomiting occurred; infection of the wound again occurred, which resulted in sinus thrombosis. The patient was cured and remained cured and the wound remained dry up to the time this paper was written.

In regard to the pathologic process in the nine cases, there is no doubt that infection of the wound was of essential importance in the development of sinus thrombosis. Therefore, the condition was true postoperative sinus thrombosis, which can be differentiated clinically from latent sinus thrombosis. One means of differentiation is the absence of all symptoms of sinus thrombosis before the operation on the bone and the long interval (usually two weeks) between exposure

of the sinus and the first appearance of symptoms of sinus thrombosis. The appearance of symptoms is of greater importance, if one realizes in how short a time after operation on the bone latent sinus thrombosis becomes manifest. Further, an argument in favor of the occurrence of postoperative sinus thrombosis is the fact that in all the cases reported severe inflammation of the wound was present, which appeared not only as a profuse fetid secretion but with pockets of retention and inflammation of the borders of the wound. Further evidence of the postoperative origin of the condition are the few manifestations found in the sinus at operation, as an obturating thrombus could not be found in any of the cases. In latent sinus thrombosis, extensive thrombosis is usually found. Further evidence is the fact that after the operation for postoperative sinus thrombosis septicpyemic temperatures usually follow; hence, the operation for latent sinus thrombosis quickly resulted in the disappearance of the blood infection. I can explain this difference only by the fact that in the first case the sinus thrombosis had been of shorter duration and in the second case, of longer duration. Finally, the high mortality in the cases reported (death occurred in six) indicates the postoperative origin or the high virulence of the infection in these cases of sinus thrombosis.

These conclusions clearly show that this was a special, clinically well characterized type of sinus thrombosis, which may be compared with postoperative thrombophlebitis well known to surgeons and gynecologists. It appears more often after chronic than after acute otitis, by which it is also differentiated from the latent sinus thrombosis which occurs in acute otitis. Exposure of the sinus favors and increases the occurrence of sinus thrombosis, but this procedure is not of prime importance in the causation.

SUMMARY

An attempt has been made to differentiate the clinical course of latent sinus thrombosis from that of postoperative sinus thrombosis. The following means of differentiation were found:

1. Latent sinus thrombosis is found more often in persons with acute otitis, while postoperative sinus thrombosis occurs more frequently in those with chronic otitis.

2. In latent sinus thrombosis, the "Komplikationszacke" appears immediately after the operation on the bone. In postoperative sinus thrombosis the interval is longer, usually about two weeks, after the operation on the bone.

3. In latent sinus thrombosis, one finds most extensive local thrombi; in postoperative sinus thrombosis, if one operates immediately after the appearance of the "Komplikationszacke," mostly mural thrombi are found.

4. The prognosis in latent sinus thrombosis is good, if the operation has been sufficiently radical. The prognosis in postoperative sinus thrombosis is unfavorable.

5. Postoperative sinus thrombosis occurs more often than one generally expects.

6. There are different causes for the development of postoperative sinus thrombosis. First is the virulent infection of the wound; hence, the exposure of the sinus is of less importance.

7. The interval before the appearance of the "Komplikationszacke" is usually about a week, especially if the postoperative sinus thrombosis is produced by injury of the sinus wall; in connection with this may be mentioned the fact that sinus thrombosis caused by spontaneous opening of the sinus—apparently because of hemorrhage from the sinus—requires a longer time to develop than that produced by simple exposure of the sinus wall. If postoperative sinus thrombosis is produced by a previous infection of the wound, the interval is usually about two weeks.

COMMENT

As I believe that the formation of fixed rules concerning the development of this condition, especially regarding the time required for development are only of average value, I would prefer to have clinical rules for the diagnosis, treatment and prognosis of a case, though I am conscious that many exceptions to these rules will be found. As an example of such exceptions, I shall cite a case, which does not follow any outlined course.

CASE 10.—A man, aged 24, presented otitis of four weeks' duration and a temperature ranging between 37.2 C. and 39.4 C. (98.9 and 102.9 F.). The sinus was exposed by antrotomy; it showed a slight periphlebitis. The next day, the temperature rose to 38 C. (100.4 F.), which, however, soon fell; seventeen days after the operation it rose again; twenty-two days after the operation, it rose to 40.2 C. and the patient had chills. The radical operation was performed; the jugular vein was ligated and the sinus opened, but no thrombus was found. The condition healed (chart 6).

It is probable that here postoperative sinus thrombosis occurred, and that the periphlebitis, which was already present at the first operation, extended farther into the sinus wall after the operation. This brings up a question which is often hard to answer. As behind a smooth, glistening sinus wall thrombosis can be found, so a sinus wall covered with granulation tissue may surround a normal lumen. When periphlebitis is found during the operation, it must be determined whether sinus thrombosis is present under the periphlebitis, in other words, whether the sinus should be incised or not. This question is answered in the textbooks. Thus, Koerner and Gruenberg wrote:

"In such cases (namely, of periphlebitis) when the sinus wall is covered with granulation tissue, if a thrombus is left, we let the sinus alone, if there is little or no fever present, and after removing all diseased bone and after entire exposure of the affected part of the dura, we await complete healing." Again, these authors wrote: "The frequent sinus thrombosis, sinus phlebitis and abscesses in the brain substance existing near an extradural abscess do not produce any special symptoms; there conditions therefore can never be excluded with certainty." Alexander also expressed a similar opinion.

Frequently, there is not enough time before the operation to observe the case sufficiently. I know of patients who come to operation with a slight fever, and in whom it becomes manifest at operation that sinus thrombosis is present under a periphlebitis. Some of the cases reported

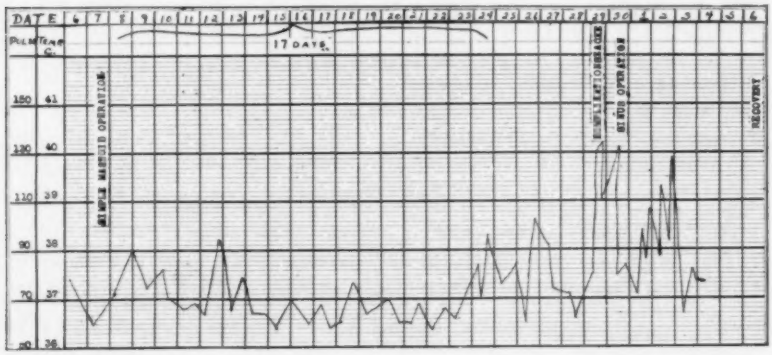

Chart 6 (case 9).—Record of pulse rate and temperature in a case of post-operative sinus thrombosis in a man, aged 27. He had acute otitis, with elevations in temperature up to 103. A simple mastoidectomy was performed. Periphlebitis and a perisinus abscess were found. The day after the operation, the temperature was 100.4 F. Seventeen days after the operation, "Komplikationszacke" occurred. Operation was performed on the sinus, and the jugular vein was ligated. A mural thrombus (?) was found. The patient recovered.

belong in this group. Cases may be observed, however, in which the patients come to operation with high fever and in which after sufficient exposure of the diseased dura, the process is arrested; Koerner and Gruenberg also pointed this out.

To be able to determine whether the dura should be incised or not, I have gathered reports of eighty-one cases, with or without perisinus abscess, in which operation for periphlebitis was performed at Alexander's clinic in Vienna. The review of these cases shows that periphlebitis offers an extraordinarily variable clinical picture, and that in some instances it runs its course without important symptoms but in other instances it exhibits a stormy course. For this study, only those

cases which have shown the most severe and the greatest number of symptoms are interesting.

In children up to 5 years of age, periphlebitis occurring as a complication of acute otitis with temperatures up to 40.3 C. (104.5 F.) is found. It is of interest that in such cases the temperature falls considerably as soon as the suppuration breaks through the cortex of the mastoid; therefore the sinus, as a result of a subperiosteal abscess, is not affected. In adults also, however, I have seen periphlebitis develop, with a temperature of 39 C., as a complication of acute otitis. The rises in temperatures that accompany periphlebitis complicating an acute exacerbation are not slight. I have observed temperatures of 39.2 C. (102.5 F.) in patients up to 15 years of age (mostly in those with cholesteatomas) and up to 38.8 C. (101.8 F.) in adults.

I do not maintain that these cases occur frequently, but one must recognize them to be able to avoid diagnostic errors. Further, I do not maintain that in all cases showing a stormy course the sinus is normal. I repeat, however, that in these cases exposure of the sinus wall has been sufficient. It is conceded, of course, that in some of the cases spontaneous healing of a thrombus resulted.

Therefore, when chills or other signs of blood infection are not present, one cannot decide on the basis of the temperature alone, whether or not the sinus is normal in a case of periphlebitis.

THE BLUE DRUM MEMBRANE*

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A bluish color over the drum membrane is occasionally observed. The usual cause of such discoloration is the development of a hemorrhagic blister occurring in certain types of acute otitis media. This condition is readily recognized, as other evidences of an acute infection of the middle ear are present. In rare instances this bluish tinge is transmitted from the inner wall of the tympanum and is due to the high position of the dome of the jugular bulb, where an extensive dehiscence in the bony covering exists. In cases of this sort, the bluish color is restricted to the lower segment of the drum membrane and, for this reason, can readily be differentiated from the blue membrana tympani described subsequently.

Occasionally it happens that the drum membrane presents a blackish-blue color extending over the entire pars tensa. I have never seen this bluish discoloration extending to Shrapnell's membrane, the pars flaccida. In the three cases I have observed, there was evidence usually of a tubal occlusion with retraction of the drum membrane. Tubal inflations could always be carried out readily. In each of the cases there was a defect in the hearing chiefly of the conduction type, a defect which was largely relieved by incision of the drum membrane and tubal inflation. The peculiar color of the drum membrane was found to be caused by an accumulation of fluid in the tympanum which after incision of the membrane was expelled by inflation into the external meatus as a glary, slightly chocolate-colored fluid. Repeated cultures in two of the cases studied failed to reveal any micro-organisms besides *Staphylococcus albus*. In all of the cases the condition was chronic, and the relief from the subjective sensations which followed incision of the drum membrane and inflation lasted only for from a few days to a couple of weeks.

The cause of this phenomena is not an acute otitis media. It is usually associated with some tubal occlusion. There was a question as to whether the fluid occupied the cavity of the tympanum or whether it was enclosed in a cyst of the membrane lining of this cavity. I was first inclined to believe that the latter was the probable condition, but the fact that distinct râles could be heard by auscultation on inflating the tube pointed rather toward fluid in the tympanic cavity.

A brief summary of two of the cases in which examination was made is given.

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* Submitted for publication, June 1, 1929.

Peculiar blue-black color of pars tensa.

REPORT OF CASES

CASE 1.—Mr. J. P. E., aged 55, seen in January, 1920, complained of symptoms in his left ear consisting of a sensation of fulness and pressure followed in the course of a few days by a watery discharge from the ear which lasted for a day or two. These attacks had first been noticed three years before, the discharge from the ear being first discovered on the pillow in the morning. At irregular intervals during the three years there had been periodic recurrences separated by a period of from two weeks to two months. The discomfort was always slight and was never associated with pain.

Examination disclosed flakes of dry, discolored secretion in the fundus of the canal. On their removal, the drum membrane presented an unusual appearance. There was no injection. All landmarks appeared normal. The membrane itself was bluish black with evidences of bulging in the upper posterior quadrant like that of a drum membrane in the first stages of acute otitis media before spontaneous rupture has taken place, except that there was a complete absence of inflammatory reaction.

There was a marked defect in hearing for the whispered voice in both ears. *C* (64 double vibrations) was heard normally in the right ear and was moderately shortened in the left. The Weber was lateralized to the left. Bone conduction was appreciably shortened. The Rinne test was positive in both ears. The C^1 fork (2,048 double vibrations) was heard normally on the right and could not be heard on the left. The Galton whistle was heard normally on the right and was not heard above 21 on the left.

Vestibular responses after rotation were normal.

The drum membrane was incised, and a glary, mucous secretion having a slight chocolate color was expelled on inflation of the tube. Aerobic and anaerobic cultures showed only *Staphylococcus albus*.

The patient was seen several times at intervals of a few weeks to a few months. Each time there was a repetition of the same symptoms described with the same relief experienced after incision of the drum membrane and expelling of the chocolate-colored fluid. No appreciable improvement in hearing resulted from the treatment. It was apparent that the defect in hearing was due chiefly to a degenerative process involving the nervous mechanism, probably not related in any way to the middle ear process which was being considered.

CASE 2.—Mr. A. J. P., aged 52, consulted me in June, 1924, because of impaired hearing in the right ear which he had first noticed about ten years previously, but which had grown appreciably worse during the preceding year. There were no associated tinnitus aurium and no symptoms referable to the nose or throat.

When first seen, the right drum membrane was somewhat retracted, with a pitting of Shrapnell's membrane. The entire pars tensa presented a peculiar blue-black color resembling that of a blueberry, as shown in the accompanying illustration. The tube was readily inflated by the Politzer method.

The functional tests of hearing showed only a moderate defect in hearing in the right ear for the whispered voice; 18 was heard at two meters and 66 was not heard. There was a moderate elevation of the lower tone limit, the perception for *C* (64 double vibrations) being only moderately shortened. The Weber test was lateralized to the right. There was no appreciable reduction in bone conduction for the *A* Edelman fork placed on the vertex. There was a defect for the Edelmann-Galton whistle above 7. The left ear was normal throughout.

The ear was inflated by the Politzer method, after which the drum membrane at once assumed its normal position. No alteration was detected in the color after

inflation. Incision through the upper posterior segment was not followed by any discharge until after inflation, when a rather thin, distinctly chocolate-colored fluid was expelled. Cultures of the fluid gave negative results.

The roentgenogram showed a complete absence of pneumatization of both mastoid processes.

After inflation of the ear drum, hearing for the whispered voice was increased from 2 to 4 meters for 18; 66 was not heard.

This patient has been seen a number of times at intervals of a month or longer, and on each occasion the condition described was found—always a retraction of the drum membrane which disappeared on inflation. Auscultation revealed a bubbling in the right ear, which indicated that the fluid was free in the tympanic cavity and was not the contents of a cyst. The relief following incision sometimes lasted as long as ten days.

CHONDROMA OF THE LARYNX*

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In a thorough search of the literature, Moore [1] found but sixty-two recorded cases of cartilaginous tumors of the larynx. He was able to find only two specimens of this type in all the museums and hospitals of London. Additional evidence of the rarity of laryngeal chondromas is contained in Grossman's article and in Crawford's communication. Grossman [2] reported that only two cases were observed in Hajek's Clinic during the past seven years. B. L. Crawford,[3] Director of Laboratories, Jefferson Medical College Hospital, stated that he has observed only three specimens of cartilaginous tumors in a large number of laryngeal neoplasms [4] which have been sent to the laboratory during the past eleven years.

The following additional cases of chondromas of the larynx have been reported in the literature since 1925.[1] These, with the case reported by me, bring the total number of reported cases to sixty-nine.

Woodburn [5] reported the case of a man, aged 66, who complained of hoarseness for five years with progressive dyspnea and loss of weight. A large round swelling was found occupying more than one half of the right hypopharynx and hiding the right cord from view. The right side of the larynx was immobile. An incomplete laryngectomy was performed leaving a large portion of the left wing of the thyroid cartilage. The growth was found attached to the right arytenoid and right wing of the thyroid. The patient died of bronchopneumonia. The pathologic report was enchondroma.

Englehardt [6] reported the case of a boy, aged 15. By mirror laryngoscopy, a tumor about one-half the size of a cherry was observed. It was below the arytenoids and was covered by dull mucous membrane. The vocal cords moved freely. A provisional diagnosis of tuberculoma was made. A biopsy was attempted; the mass was found to be hard, so mucous membrane only was removed. Exam-

* Submitted for publication, June 1, 1929.

* From the Chevalier Jackson Bronchoscopic Clinic, Jefferson Hospital.

* Read at the meeting of the American Laryngological Association, in Atlantic City, N. J., May 20, 1929.

1. Moore, I.: Cartilaginous Tumors of the Larynx, J. Laryngol. & Otol. **40**:9 (Jan.) 1925.

2. Grossman, B.: Cartilaginous Tumors of the Larynx: Report of Two Cases, Monatschr. f. Ohrenh. **61**:1235 (Nov.) 1927.

3. Crawford, B. L.: Personal communication to the author.

4. Among these are included specimens of practically all of the laryngeal neoplasms removed in the Chevalier Jackson Bronchoscopic Clinics.

5. Woodburn, J. J.: Enchondromata of the Larynx, M. J. Australia **1**:645, 1926.

6. Englehardt, G.: Anatomy and Treatment of Tumors of Laryngeal Cartilages, Ztschr. f. Hals-, Nasen- u. Ohrenh. **16**:77 (July 31) 1926.

ination of this suggested papilloma. The tumor continued to increase in size with the development of dyspnea. Laryngofissure was performed. Under the left arytenoid there was a mass the size of a walnut and hard as bone. A portion was removed and was reported by the pathologist as an ossifying chondroma. The patient made an uneventful recovery. This is undoubtedly the youngest patient with chondroma of the larynx whose case is reported in the literature.

Grossman [2] reported two cases. In one case, that of a man, aged 61, the left half of the larynx was involved, but the right cord was normal. A conservative operation was first performed. When he was examined eight months after operation, there was recurrence of the growth. Laryngectomy was performed with apparently successful results. The patient died thirteen months later of pulmonary tuberculosis.

In the second case, that of a man, aged 53, the involvement was also left-sided. There was marked dyspnea which necessitated tracheotomy. The patient did not make a satisfactory recovery, and later died of pyemia. At autopsy, there was found a typical chondroma involving the cricoid cartilage.

Birkett and Hutchinson [7] reported a case of chondroma of the larynx appearing in a man, aged 49, who had been complaining of hoarseness for about fifteen months. Examination of the larynx showed fixation of the left vocal cord which was in the midposition. Below the cord there was a bulging inward of the lateral wall. Near the posterior attachment of the right vocal cord was a small mass, apparently a papilloma. This was removed by direct laryngoscopy and proved to be a papillomatous hyperplasia. The patient was kept under close observation for two years, when, because of the progressive increase of the swelling and the development of dyspnea, thyrotomy was done. The tumor was definitely left-sided and originated in the left wing of the thyroid cartilage. The histologic report was chondroma showing calcification and bone formation. The patient developed a pulmonary and a cardiac complication and did not recover.

In Neilson's [8] case, that of a man, aged 46, the tumor originated from the thyroid cartilage and was of eight years' duration. It appeared as a large lump on the left side of the neck, causing no inconvenience and producing practically no respiratory obstruction. The laryngeal movements were normal. Extirpation was effected by external operation without removal of the larynx. Recovery was uneventful.

A complete statistical review of previously recorded cases and the most recent views on the etiology, classification and pathology of cartilaginous tumors of the larynx reference are given in Moore's [1] article.

Certain difficulties are encountered in diagnosis. Experience necessarily is limited, since few laryngologists have observed more than one case. The tumor, commonly springing from the cricoid cartilage, is chiefly subglottic and in its incipiency is often overlooked, especially if the examination is made only during phonation. Moore recommended that "the examination always be made with the cords in the respiratory position and with the patient in the upright position, after Killian's method." Often, the first abnormality in the larynx is immobility of one vocal cord. In commenting on fixation of the vocal cord in the presence of a laryngeal tumor, Sir St. Clair Thomson [9] pointed out that "immobility of

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7. Birkett, H. S., and Hutchinson, K.: Chondroma of the Larynx, Canad. M. A. J. **17**:703 (June) 1927.

8. Neilson, F. A.: Chondroma of the Thyroid Cartilage, J. Laryngol. & Otol. **44**:127 (Feb.) 1929.

9. Thomson, Sir St. Clair: Ecchondrosis of the Larynx, J. Laryngol. & Otol. **40**:1 (Jan.) 1925.

a cord is not necessarily, as Semon originally suggested, absolutely characteristic of a malign growth." He further stated that "neither the solid sensation conveyed to the laryngeal probe nor the 'raw potato' like appearance on section are characteristic of enchondroma of the larynx." In a case reported by him those "characteristics" were present, but the growth proved to be an epithelioma.

TREATMENT

According to Moore,[1] the treatment for chondroma of the larynx is analogous to that for cancer in the same location. Although consid-

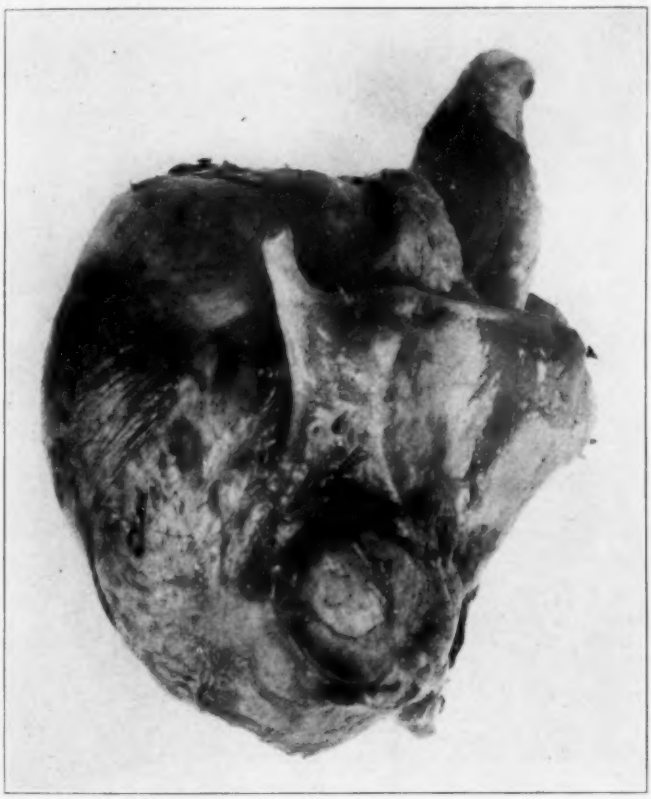

Fig. 1.—Lateral view showing a large nodule on the outer surface of the right wing of the thyroid cartilage at its lower angle. A portion of this was excised for biopsy when the tracheotomy was performed.

ered as a benign neoplasm, malignant characters may be assumed, hence the importance of early and complete removal of the entire growth with its capsule. Recurrence following incomplete removal was observed in Waggett's [10] case and in several other instances.

10. Waggett, E. B.: Chondroma of the Cricoid Cartilage of the Larynx, J. Laryngol. & Otol. **40**:27 (Jan.) 1925.

Peroral endoscopic removal may be practiced if the tumor is small and pedunculated or if it involves the epiglottis. Usually this method is inadequate, although Moore recorded seven cases in which it was successfully practiced. The methods of choice are laryngofissure or laryngectomy for the endolaryngeal forms of growth and some form of extralaryngeal operation in those cases in which there is no encroachment on the airway, as in Neilson's case.[8]

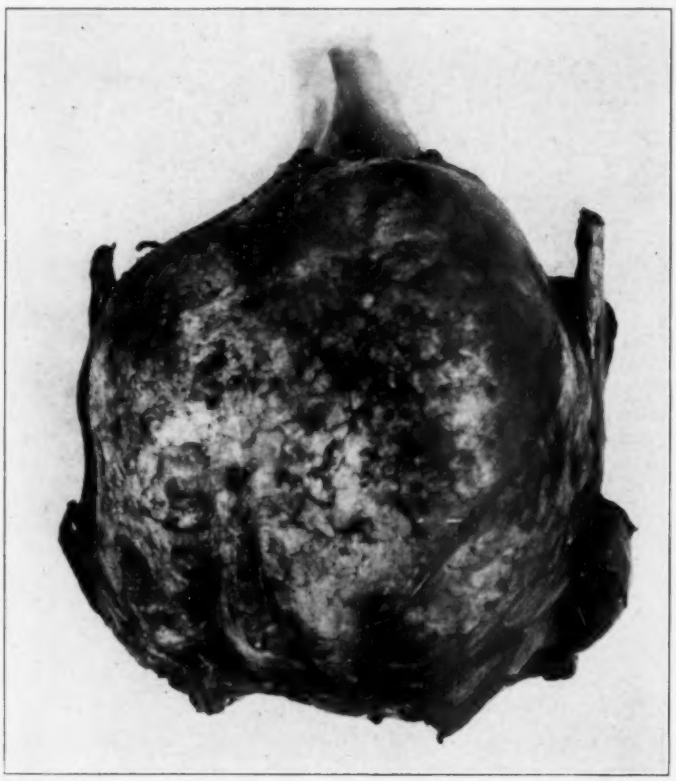

Fig. 2.—Observed from its posterior aspect the growth completely occludes the interval between the thyroid wings. In this plane the growth measured 6.5 by 6 cm.

REPORT OF A CASE

A case of chondroma of the larynx is reported, and is of interest because of the following points: (*a*) a history of progressive hoarseness of six months' duration; (*b*) immobility of the left cord with impairment of motility of the right cord; (*c*) no evidence of neoplasm by mirror or by direct laryngoscopy; (*d*) on examination four years later, marked dyspnea and dysphagia with a large globular mass almost com-

pletely occluding the upper orifice of the larynx and laryngopharynx; (*e*) operative treatment and subsequent progress.

A man, aged 48, was referred to the Chevalier Jackson Bronchoscopic Clinic, Jefferson Hospital, during March, 1924, by Dr. Lawrence Flick, because of hoarseness and dyspnea. The onset of these symptoms dated back to an acute cold contracted six months before. When the patient was examined by Dr. Flick, there was a question of a quiescent pulmonary lesion, but because of the hoarseness he requested a laryngeal examination. By mirror laryngoscopy, there was found fixation of the left vocal cord in the midline with impaired motility of the

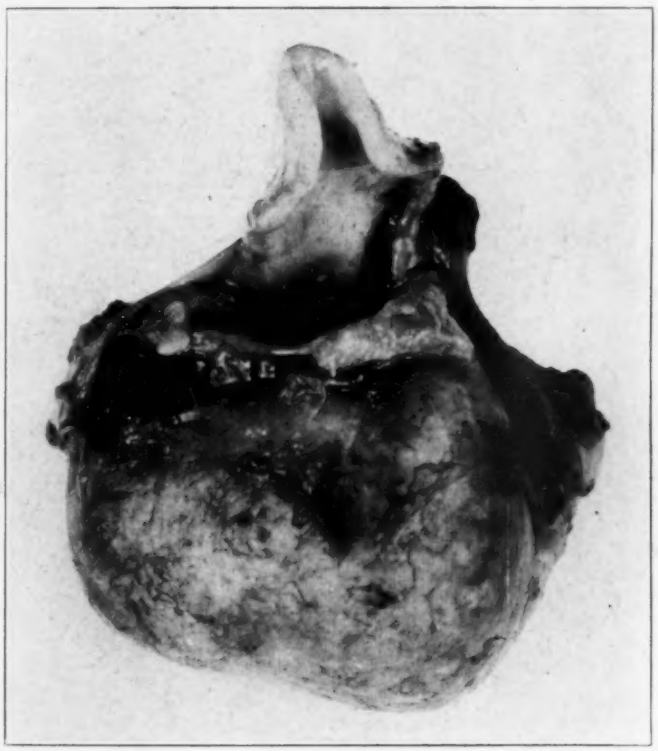

Fig. 3.—Viewed from its superior aspect. A small interval exists between the anterior margin of the growth and the anterior commissure of the larynx.

right cord. By direct laryngoscopy, Dr. Chevalier Jackson corroborated these observations; the vocal cords were found thickened and inflamed, and there was infiltration of both arytenoid eminences. No evidence of neoplasm was observed. Vocal rest and repeated observation of the larynx were recommended. The patient consulted no physician until four and a half years afterward (August, 1928), when severe dyspnea with dysphagia developed. Dr. E. R. Mayerberg, who was consulted, immediately referred him to the clinic.

On examination of the larynx, there was found almost complete occlusion of the hypopharynx by a large globular mass covered by moderately inflamed mucous membrane which contained a few enlarged tortuous vessels. Anteriorly, a small

distorted epiglottis projected upward from the margin of the tumor. There was no ulceration. The wings of the thyroid cartilage were widely separated, and over the outer surface of the right ala small, hard, immobile nodules were palpated (fig. 1). Tracheotomy was promptly performed because of impending asphyxiation. At the same time the tissues overlying the right thyroid wing were elevated, and one of the firm nodules, apparently cartilage, was removed for histologic examination. Dr. B. L. Crawford reported this as chondroma.

In consultation with Dr. Jackson, laryngectomy was decided on; this was performed with the patient under ether anesthesia, administered by the rectal method.

Fig. 4.—Photomicrograph made from a section of chondroma of the larynx. The tissue is made up of small collections of cartilage cells with a large amount of intercellular substance.

He made a satisfactory recovery, and was discharged on the twenty-first day after operation.

The larynx and growth were submitted to Dr. B. L. Crawford, who reported as follows: The specimen consisted of a larynx and epiglottis; the cavity of the larynx was practically completely filled by a large firm globular mass which measured 6.5 by 6 by 4 cm (fig. 2). A narrow airway existed between the growth and the anterior commissure (fig. 3). The arytenoids and the posterior portion of the cricoid cartilage were involved in the mass. On section, the mass cut with resistance; the cut surface was uniformly gray and was friable, with the con-

sistency and appearance of cartilage. On microscopic examination, a greater portion of the tissue was composed of small nodules made up of cartilage with a large amount of intercellular substance. Between the nodules were small areas of connective tissue which contained numerous blood vessels. Small calcific deposits were scattered throughout (fig. 4).

A diagnosis of chondroma was made.

COMMENT

The history of hoarseness of six months' duration with fixation of one vocal cord and impairment of motility of the other, in the absence of a demonstrable lesion in the larynx, was confusing. When the patient was examined four and a half years later, there was little doubt as to the diagnosis.

With involvement of both arytenoids and the cricoid in the process, there was little hope for a conservative form of treatment. When the thyroid was split in the midline at the time of operation, it became apparent that complete removal of the larynx was necessary.

CONDITIONS OF THE OPTIC NERVE CAUSED BY DISEASE OF THE SINUSES*

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NEW YORK

Of the various conditions of the eye due to disease of the sinuses none are so well recognized or established as the diseases of the optic nerve. It has been several years since Onodi (1904) and others demonstrated the close relationship of the optic nerve to the sphenoid and posterior ethmoid cells. Since then, a large accumulation of clinical cases has shown that the causal relationship exists beyond question. There are today few ophthalmologists of experience who on seeing an inflammation of the optic nerve do not send the patient to a rhinologist for a report as to the presence of ethmoiditis or sphenoiditis. Many times a positive report is returned, but on other occasions nothing suggestive of disease is found in the nose. This happens so frequently that evidently there is a large class of cases in which no intranasal symptoms occur, or else they are peculiarly difficult to determine. I think that the latter is correct, and that it requires a great deal of careful and patient study on the part of the rhinologist to suspect disease of the sinuses when it exists in a relatively latent form. My own experience does not enable me to say whether disease of the nerve exists more frequently in the cases in which pus is discharged from the sinuses than in the latent ones in which there is little or no discharge. After some years of study and clinical experience, however, I am inclined to think that the cases in which there is a free discharge are not apt to be those in which the peculiar disease of the bone exists that is evidently the true cause of the condition of the eye.[1]

In clinical work at the Manhattan Eye, Ear and Throat Hospital it was customary, for several years after the publication of the earlier papers, to have a nasal examination and even to institute nasal treatment in suspected cases. It was baffling, however, that after everything else had been excluded, the condition of the optic nerve progressed to complete atrophy. This occurred mainly in one-sided cases in which a local rather than a constitutional cause seemed probable.

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* Read before the meeting of the Pacific Coast Ophthalmologic and Otolaryngologic Society at Salt Lake City, July 2, 1929.

1. MacKenty said that in cases in which there is pus, a thick protective membrane is present in the sinuses. In the latent cases, the membrane is thin, allowing the passage of toxins. He thought that sensitization of the tissues, lateral to the sinuses, causes an allergic reaction—edema.

During these years the operation on the sphenoid and ethmoids was greatly developed and improved, and changed from a relatively formidable and dangerous procedure to one in which poor results became rare—of course, in the hands of skilful and experienced surgeons. It seemed wise, therefore, to risk something and to have the sinuses exenterated even when no nasal symptoms were manifest, rather than to sit by passively and allow the eye to become blind.

The first suitable case, which was seen at the clinic late in 1916, showed a low-grade retrobulbar neuritis in the left eye. The patient was a girl, aged 15 years, in good general health, who had rather suggestive headaches but no other symptoms. The vision had been gradually failing for several weeks and at the time that she was first seen was only 10/200. The field was concentrically contracted. I urged Dr. J. E. MacKenty, who had examined her and found nothing suggestive in the nose, to operate. He performed a complete exenteration of the ethmoids and sphenoid on the left side. He found nothing suggestive during the operation, and remarked afterward that he felt as if he was operating on normal sinuses. The patient made an uneventful recovery from the operation, and in a few days her vision began to improve. In a little more than a week the vision was 20/20 and the field was normal. The condition of the optic nerve cleared up, and all haze disappeared; the only remaining sign was that the nerve continued to be slightly pale. Unfortunately, it was possible to observe the patient for less than a year; but on the last observation the vision was normal, and no relapse had occurred.

This case presented a rather striking lesson. Patients continued to be operated on, in the main with good results. This was the first latent case in which an operation had been performed, although a certain number of patients with a frank purulent discharge had been operated on during the previous five or six years. The operations were gradually extended to patients with other diseases of the eye—retinitis, choroiditis, and even iritis—and the results were so good that the practice of operating in the presence of suggestive symptoms in the eye became established and continues until the present time. In the *Laryngoscope* for July and August, 1928, I reported my experience [2] in forty-four cases of disease of the sinuses taken from over 9,000 cases in my private practice, occurring between 1917 and 1927, inclusive. The cases in the clinic of the Manhattan Eye, Ear and Throat Hospital have been, of course, far more numerous.

From this work it has become more and more evident that the nasal symptoms could not be depended on, and that it was important to study the symptoms in the eye so that a diagnosis of strong probability could be made and the operation on the sinuses could be requested on the condition of the eye alone. I see no other way out of a situation which, in most instances, means loss of sight if the problem is not

2. Thomson, E. S.: Ocular Involvement in Sinus Disease, Laryngoscope **38**: 439 (July) and 521 (Aug.), 1928.

solved. I feel strongly that in the absence of more exact methods of diagnosis the study of the clinical features is most important. I shall attempt to describe them in this paper.

DISTURBANCE OF THE OPTIC NERVE

There are three types of disturbance of the optic nerve occurring as the result of disease of the sinuses. The one most commonly spoken of in the literature and perhaps most frequently occurring takes the form of retrobulbar neuritis. The nerve is slightly hazy and pale, with vessels either normal or somewhat diminished in size. Vision is markedly reduced, the blind spot is enlarged and the field soon becomes contracted. The color fields may be contracted or there may be a central color scotoma. There is hardly any question but that this form represents a plastic inflammation of the part of the nerve that lies nearest to the sphenoid and posterior ethmoid cells. I am almost tempted to say that disease of the sinuses causes a considerable proportion of the cases of retrobulbar neuritis, at least in my locality. Those who for some reason are inclined to doubt this factor continually speak of multiple sclerosis as the most common cause. This has certainly not been the case in my experience. Most of the cases that I have reported have been under observation too long to make the diagnosis of multiple sclerosis tenable. For many years retrobulbar neuritis has been mentioned in the literature as an accompaniment of certain cases of multiple sclerosis, but in such cases there are general symptoms. Also there is no proof that a toxic cause, such as disease of the sinuses, was not present as well. The cases of disease of the optic nerve from multiple sclerosis that I have seen have shown paracentral or central scotomas and have progressed to optic atrophy. In other words, the more common condition in multiple sclerosis is atrophy of a fair degree of progression, while in disease of the sinuses the neuritis is toxic from absorption through the periosteum or from a more direct invasion of a deep osteitis of the sella. It speedily progresses to atrophy if the disease of the sinuses is not checked, and requires early operation if serious damage to the nerve is to be avoided.

The second type of disturbance of the nerve, which is perhaps nearly as common as the first mentioned, is plastic neuritis. The nerve is reddened and covered with plastic exudates which usually extend irregularly into the retina. There are usually hemorrhages and perhaps an extensive chorioretinitis with large areas of retinal edema. There is, of course, tortuosity and engorgement of the vessels and swelling of the disk, which may run as high as 6 or 7 diopters. Vision is much depressed and the blind spot enlarged, although contractions of the field from the nerve alone do not occur early. The condition,

of course, is toxic; if an operation is not performed, atrophy follows speedily, the more speedily the more severe the process is.

In both retrobulbar neuritis and plastic neuritis the disease is apt to be one-sided, a fact which strongly suggests local causation. Double-sided neuritis does occur, but only when the disease of the sinuses is of long duration and when both sides are extensively involved. One nerve is usually affected before the other.

The third form is characterized by sudden functional depression with no change in the appearance of the optic nerve. It may be unilateral or bilateral. Central color scotoma is relatively common, while contraction of the visual field occurs only after the condition has existed for several days or perhaps weeks. The blind spot is usually enlarged.

The pathology in this type is obscure. The two factors of infection and pressure have been considered, but the clinical course makes either factor doubtful. Long periods of depression—weeks and even months—may be followed by a return to normal in two or three days after the operation on the sinuses, and while the danger of atrophy is ever present it seems to occur with relative slowness. Hysteria must be carefully excluded, but the fixed character of the visual tests, the absence of other hysterical symptoms, the sluggishness of the pupils and the general consistency of the symptoms will make the diagnosis fairly positive. In these cases especially, it is usual to find no local disturbances in the sinus, and the rhinologist seems to operate on normal tissues; nevertheless, after a complete operation the vision returns to normal with a rapidity that seems marvelous. Histologic examination of tissue from the posterior ethmoid and sphenoid walls may show chronic changes in the bone. A pure papilledema does not occur as the result of disease of the sinuses, and there seems to be no real reason why it should.

CHARACTERISTICS OF DISEASE OF THE SINUSES

It has long been conceded that pus in a confined cell can cause ocular infections, and this class of cases presents less difficulty in diagnosis. The cases in which disease of the sinuses is latent, however, form a much more important group. Apparently the infection is not confined to the mucous membrane but spreads directly into the substance of the bone, causing an osteitis of varying intensity but with little or no nasal discharge.[3] This process passes through a hyperplastic stage,

3. MacKenty said that careful and repeated examination, especially by posterior rhinoscopy, rarely fails to reveal changes in the posterior superior cells, enlarged vessels, thickened plica on the septum, changes in the color and texture of the mucous membrane, and sometimes a watery, acrid discharge that is scanty yet productive of changes in varying degree on the posterior lateral pharyngeal wall, thickening and congestion.

a period during which the bone tends to re-form. The anterior wall of the sphenoid having been removed, the bone tends constantly to fill in and is sometimes kept open with difficulty. Finally it becomes eburnated, and the tendency of the infection to spread becomes markedly lessened. It follows that operation is most effective during the hyperplastic stage; but the difficult point to decide is when the operation would no longer be effective. I am strongly of the opinion that if the proper opportunity is missed—which is during the early stage of the process—less is accomplished for the reason that the local infection has to some extent subsided, as well as that structural damage in the eye cannot be repaired. This question is more difficult to answer in uveal diseases than in inflammations of the optic nerve, for the reason that damage to the nerve occurs in a relatively short period of time and that one must operate early—sometimes within a few days—if the best results are to be secured. At times the osteitis leads to caries and necrosis. I have seen several cases in which the meninges above the sella were entirely exposed. There is no question but that at times there is extension of the inflammatory process from the sella to the meninges and a localized meningitis. Of course, fatal results are to be anticipated, but they do not always occur.

I have in mind one case in a young man, aged 25, who had a plastic neuritis and no perception of light; yet the condition cleared up to 20/30, two months after operation on the sinuses. The headaches were severe and the diminution of vision was out of all proportion to the appearance of the nerves. In another case a hemianopsia existed, with vision of 2/200, showing definitely a disturbance back of the chiasm. The condition also cleared up to a certain extent, indicating absorption of the meningeal exudates.

When the optic nerve is concerned, the location of the active process is in the posterior ethmoids and sphenoid in the vast majority of cases, although it must always be remembered that structural anomalies are the rule rather than the exception. I have seen a frontal sinus which extended backward and finally came in close relation with the optic nerve. For this reason x-ray pictures are a most valuable aid and demonstrate the anatomy perfectly, while for the diagnosis of the actual presence of the inflammation their value is relatively small. It is also well to remember that it is scarcely possible to have a strictly isolated area of disease of the sinuses in the class of cases described. While the trouble may center in the sphenoid and ethmoids, the other sinuses are apt to be involved, and frequently the tonsils as well are affected. Therefore, experience has shown that it is best to perform a complete operation, and that it is much more dangerous to leave diseased tissue in than to take it out.

THE OPERATION

The operative technic is so important that I am repeating the already published account:[2]

"MacKenty believes that all septal tissue in the ethmoids should be removed and the ethmoids converted into a single cavity, and that if this be done the danger of hemorrhage is reduced to a minimum. He does a complete radical pansinus operation on the affected side. A submucous resection of the nasal septum is done at the same time, to give more room for the procedure. Every ethmoid cell is removed out to the orbital plate and up to the base plate. By this procedure the cells on the floor of the frontal are thoroughly removed and of necessity the frontal sinus stands well open. The entire anterior sphenoid wall is taken down. The antrum is opened as widely as possible under the inferior turbinate. If the other side is evidently diseased, it is similarly treated. His reasons for such a radical procedure are that any ethmoid cells left are closed by the traumatism of the operation, their drainage is interfered with, and they are potential sources of future trouble. This throws the ethmoid labyrinth and sphenoid into the nasal cavity. Great care must be taken not to injure orbital wall of the base plate, and the sphenoid cavity should never be curetted. The tonsils should be removed if diseased or if there is a history of tonsillitis.

"The operative procedure usually adopted by Faulkner is a thorough intranasal exenteration of the ethmoids, with enlargement of the sphenoid opening sufficient for drainage and subsequent treatment. An intranasal opening in the antrum is usually sufficient, but in some cases a radical antrum operation may be necessary. The frontal sinus very rarely acts as a focus of infection, as its drainage opening is in a more dependent position. A unilateral operation may be sufficient, but more frequently both sides will have to be operated on. Tonsillectomy is necessary in nearly all cases and has a favorable influence in enabling the patient to overcome the infection in the sinuses. A submucous resection of the septum should be performed to give better access to the surgical field."

I am entirely in accord with the contention of the two surgeons quoted. The operation to be effective should be thorough and complete. In one case in which an overcautious and incomplete operation was performed by a good surgeon who did not agree with the two mentioned, a severe reaction occurred with a hemorrhage into the nerve sheath, and total atrophy of the nerve resulted. Fortunately, such a calamitous result is not often seen, even at the hands of indifferent operators. What usually happens is that an incomplete operation is followed by no improvement.

A case which illustrates this well was that of a woman of good health who presented herself to my associate, Dr. Frey, with a retrobulbar neuritis in the right eye and vision restricted to hand movements. When he told her that the process looked as though it came from disease of the sinuses, she replied that her physician had opened the sphenoid and ethmoids without helping her in the least. The trouble had been going on for three weeks. She was referred to Dr. MacKenty's associate, Dr. W. R. Brandon, who reported that a great deal of ethmoid tissue still remained in situ and that there were evi-

dences of inflammation. Dr. Brandon performed a complete exenteration of the ethmoids and sphenoid, and at once the vision began to improve. In ten days, the vision was 20/15. While this was an extreme instance, the experience in lesser degree is one that has frequently occurred. This experience and others like it rather disprove the idea that has been advanced in some quarters that the benefit from the operation is due to depletion.

Depletion at times has a certain effect, but from my experience it seems evident that the condition of the eye will not improve unless all diseased tissue is removed and the source of the infection is thereby cut off. A rather curious complication occurred in three cases that I have seen. When an incomplete operation has been performed and the ethmoids are finally cleared of hard septums, perhaps adherent to each other, it is not always possible to avoid fracture of the orbital plate and hemorrhage into the orbit. In one striking instance the lids were so swollen that retractors had to be used to open the eye. When the optic nerve was viewed, it was found that the pressure was so great that the nerve was white and that no blood was coming through the vessels. Of course, atrophy would have speedily followed. An incision was made to the upper inner side of the orbit, the orbital fascia was split, and the tension was relieved by sucking out the blood while the tissues were massaged. By the following day the blood was flowing freely through the nerve, and complete recovery followed.

Recovery After Operation.—When a thorough operation has been performed, the optic nerve within forty-eight hours begins to show signs of improvement. The functional cases mentioned, in which no lesion of the nerve can be seen with the ophthalmoscope, frequently show rapid improvement. Vision amounting to light perception only will improve in two or three days to 20/15. Retrobulbar neuritis is slower, while plastic neuritis may require as long as several weeks to subside. The speed of resolution depends on the amount of plastic material to be absorbed, but it is always a relatively rapid process. Cases clear up more rapidly than they would if the cause were different, and the clinical course is strongly suggestive of the correctness of the diagnosis. Again let me say that this operation should be performed whether nasal symptoms exist or not. To wait for nasal symptoms in a serious type of case is to court disaster.

Complete recovery depends, of course, on the stage at which the operation is performed. In the functional cases, considerable time may elapse and still the vision will return. I have seen one case in which the vision was reduced to light perception for six months and yet complete recovery occurred. With the plastic forms, however, great haste is necessary. The operation should be performed as soon

as the diagnosis is made if destruction to the nerve tissue, partial or complete, is to be avoided. A temporizing course may be allowable in the functional cases or in certain cases of iritis or choroiditis, but in retrobulbar neuritis or in plastic neuritis, it is not to be thought of. I have seen a number of cases in which suction or intranasal treatment was used instead of an operation, and there was not one of these in which the nerve was not damaged to a greater or lesser degree.

Course When no Operation Has Been Performed.—In a certain number of cases of the retrobulbar type, there is partial recovery without operation. The nerve is found to be white, with vessels diminished in size, vision reduced to 20/50 or 20/100, color perception uncertain and a peculiar tendency of the visual image to waver. The usefulness of these eyes is seriously impaired. In these cases the correctness of the diagnosis is always open to question, yet one who studies the clinical characteristics of optic neuritis caused by disease of the sinuses will usually feel fairly certain of his ground.

What lends color to the idea that there is an osteitis which runs its course is the fact that in these cases of partial damage no further deterioration may occur for years. In the cases of marked plastic neuritis, however, nonoperative treatment is usually followed by total atrophy.

DIAGNOSIS

The diagnosis in the functional types is mainly a question of differentiation between disease of the sinuses and hysteria—not a particularly difficult one if time is taken to study the case. In the plastic forms, the diagnosis will rest on exclusion through general tests (Wassermann, etc.), the presence of suggestive nasal conditions (obstruction, congestion, discharge) or the persistence of bacteria in the nose. Finally, if the process is marked and one-sided, it is strongly suggestive of a local process, for in the vast majority of cases optic neuritis from a constitutional cause is two-sided. There is no reason why one optic nerve should be immune to a constitutional toxin that affects the other. When both optic nerves are affected, the diagnosis is somewhat more difficult. If no nasal observations can be elicited, the diagnosis will rest mainly on the exclusion of other causes, taken in connection with the fact that the type of the inflammation corresponds to one of the types described. The condition is usually more advanced in one eye than in the other, but in general it may be said that the visual depression seems greater than the ophthalmoscopic picture would indicate. The enlargement of the blind spot is confirmatory of the severity of the inflammation. Double-sided neuritis occurs in the young as well as in the old. My youngest patient, whose case has already been reported, was 13 years of age. She made a brilliant recovery after a double-sided operation and now, four years afterward, has normal vision.

Another point in diagnosis is the presence of an associated retinitis. Areas of whitish edema with patches of yellowish exudate occur near the disk and sometimes spread for a considerable distance over the retina. Hemorrhages are present, and thrombosed vessels frequently occur. This particular association of neuritis and retinitis in these types seems to occur more frequently in disease of the sinuses than from other causes. The retinal edema clears up rapidly after the operation on the sinuses, but is apt to leave scotomas and distortion of the image which, however, may improve for months afterward.

As for retrobulbar neuritis in cases of multiple sclerosis, it will be admitted, I think, that there is no reason why in a case of multiple sclerosis there should not also be disease of the sinuses. As I see it, the only way to prove or disprove the relationship is to operate. If no operation is performed, the cause of the neuritis is not known, as secondary atrophy occurs in any event. Why, therefore, ascribe to a degenerative process a condition that is definitely toxic?

LATE CASES

A rather difficult problem is presented at times by the late cases with pale nerves, patients who come for treatment from three to twelve months after the onset of the nerve disturbance. If the condition is an osteitis which has run its course, it is manifestly useless to operate. Some cases suggest this strongly; others show a slight haziness of the nerve, even if it is not white, and perhaps give the appearance of activity in the ethmoids. In these cases I usually give the patient the benefit of the doubt and ask for an operation on the sinuses. It is surprising what improvement occurs in these late cases if evidence of a plastic inflammation is present. Considerable improvement in visual acuity can be secured, as I have observed a number of times.

In my former paper, already mentioned, I reviewed certain articles down to 1926. As the feeling of many writers is changing, it seems appropriate at this point to mention briefly the views of certain writers within the past two years.

Brajnina [4] reported three cases of retrobulbar neuritis from the Moscow Eye Clinic in which the vision returned to normal after the operation on the sinuses. Pus was found in the ethmoids in one case, while in the other two "the mucosa of the accessory sinuses was absolutely normal." He concluded that inflammation of the optic nerve is a relatively rare complication of chronic diseases of the sinuses.

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4. Brajnina, R.: Eye Diseases in Chronic Inflammations of the Nasal Accessory Sinuses, Zurnol. Uschnych:Golovych Boljasny **5**:274, 1928; Klin. Monatsbl. f. Augenh. **80**:850, 1928.

Brown [5] emphasized the importance of testing the visual field and the central threshold for color in the diagnosis of the hyperplastic type of inflammation of the sphenoid sinus.

Carmi and Pietrantoni [6] made a distinction between the retrobulbar neuritis with manifest disease of the sinuses and that in which no change in the sinuses is demonstrated but in which rapid improvement follows surgical intervention. Suggestive nasal symptoms are discussed in detail. Anatomic investigations were carried out on the fetus after injection of Chinese ink into the jugular vein or into the superior vena cava. Extensive relations were found between the vascular system of the sinuses and of the orbit.

Clement [7] considered retrobulbar neuritis the most common and the most important of the ocular diseases originating in the sinuses. The ethmoid and sphenoid groups are the cause of visual disturbance in the majority of cases. The lesions are completely latent and must be carefully looked for. The cases of retrobulbar neuritis are related to vasomotor, reflex or anaphylactic disturbances. In suspected cases intervention must not be delayed.

Cords [8] thought that multiple sclerosis is a more frequent cause of retrobulbar neuritis than is sinusitis. The rhinogenic form is rare. Central scotoma is by no means rarely the first symptom of multiple sclerosis.

Deichler [9] reported a case of retrobulbar neuritis from infection of the frontal sinus.

Dreyfus [10] was opposed to the so-called "interventionists," who demand intranasal intervention without pathologic evidence, and agreed with the "abstentionists" who claim that almost every case of acute retrobulbar neuritis heals spontaneously.

Dworjetz [11] reported a case of optic neuritis from empyema of the antrum.

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5. Brown, M. Earle: Indications for Surgical Procedure in Sphenoiditis from Ophthalmological Studies, New Orleans M. & S. J. **80**:364, 1927.

6. Carmi, A., and Pietrantoni, L.: Contribution to the Study of Retro-Bulbar Neuritis and Its Relations to Congestive Conditions of the Naso-Orbital Region, Rev. oto-neuro-oft. **5**:101, 1928.

7. Clement, R.: Ocular Complications of Sinus Origin, Presse méd. **34**:293, 1926.

8. Cords: Critical Comments on Rhinogenic Retrobulbar Neuritis, Klin. Monatsbl. f. Augenh. **69**:129, 1922.

9. Deichler, L. Waller: Retrobulbar Neuritis, Due to Frontal Sinusitis, Am. J. Ophth. **9**:346, 1926.

10. Dreyfus, P. A.: Spontaneous Cure of Retrobulbar Neuritis, Bull. Soc. d'opht. de Paris **6**:354, 1928.

11. Dworjetz: Eventual Connection Between Eye Diseases and Affections of the Accessory Sinuses and the Teeth, Arch. v. Ophthalmol. iii. **1**:412, 1926; Klin. Monatsbl. f. Augenh. **76**:903, 1926.

Esch,[12] in retrobulbar neuritis, recommended the evacuation of the posterior ethmoids and sphenoid sinus.

Fejer [13] reported a case of papillitis in which the patient recovered after a spontaneous discharge of pus from the sinuses.

Forschner and Sommer [14] stated that in six of twenty-nine cases of retrobulbar neuritis they could assume with great probability a rhinogenic etiology, "always leaving open the question of multiple sclerosis."

Griscom and Monroe [15] reported a successful recovery after operation from optic neuritis caused by purulent ethmoiditis. They attached great importance to field studies.

Halphen and Pages [16] reported a similar case with no marked ethmoidal observations.

Herzog,[17] in 28 cases of retrobulbar neuritis, found disease of the sinuses in 4, normal sinuses in 12 and various general causes in 16. In 500 cases of suppuration of the accessory sinuses, 47 (9.4 per cent) had retrobulbar neuritis, 33 were chronic and 14 acute. In chronic inflammation there is a subsequent reaction on the part of the bone which leads to thickening of the bony trabeculae and therefore to a closure of the avenues from the inflammatory focus to the optic nerve. Rhinogenic optic neuritis, accordingly, is to be interpreted as a circumscribed serous meningitis. Herzog packed the nasal cavity with epinephrine and found improvement, which he thought was confirmatory of the rhinogenic origin of the neuritis. He believed that if the neuritis does not improve under epinephrine packs there is another etiology, most probably multiple sclerosis.

Janssen [18] believed in an exploratory operation of the ethmoids and sphenoid, even in the presence of negative observations on the sinuses.

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12. Esch, A.: The Question of Operation in Retrobulbar Neuritis of Nasal Origin, Klin. Wchnschr. **7**:938, 1928.

13. Fejer, J.: Spontaneous Regression of Ocular Phenomena Caused by Ethmoid Cell Suppuration, Hungarian Ophthalmol. Society, Budapest, April 8, 1927, Klin. Monatsbl. f. Augenh. **78**:707, 1927.

14. Forschner, L., and Sommer, J.: Aural and Nasal Findings in Acute and Chronic Retrobulbar Neuritis (Toxic Amblyopia), Monatschr. f. Ohrenh. **62**:1, 1928.

15. Griscom, I. M., and Monroe, M. M.: Visual Field Studies in a Case of Optic Neuritis Secondary to Sinus Disease, Arch. Ophth. **56**:244 (May) 1927.

16. Halphen and Pages: Retrobulbar Neuritis and Sphenoidal Surgery, Rev. d'oto-neuro-opht. **6**:32, 1928.

17. Herzog, H.: Retrobulbar Neuritis, Arch. f. Augenh. **99**:292, 1928.

18. Janssen, H.: A Contribution to the Elucidation of the Clinical Relations Between the Nasal Accessory Sinuses and the Orbit, More Particularly the Optic Nerve, Arch. f. Ohren-, Nasen- u. Kehlkopfh. **109**:188, 1922.

Krassnig [19] reported six cases of retrobulbar neuritis in which the patients were operated on with successful results.

Leichsenring [20] reported three cases of optic neuritis cured by operative intervention. He advocated operation even in the presence of negative observations on examination of the ethmoids.

Meller and Hirsch,[21] who reported several successful cases, believed in surgical intervention as "these operations are hardly to be designated as dangerous at the hands of an experienced rhinologist."

Sargnon and Colrat,[22] in a carefully written paper, mentioned forty-three cases of ocular lesions, twenty-one of which were optic neuritis, reported at the Venice Congress. Since that time they have observed and operated on seventeen patients, all by the endonasal route. They distinguished sharply between the purulent and latent cases: In suppurative sinusitis an infectious pathogenesis is generally conceded; in the latent cases there are theories of infection and reflex theories. They believed that a trigeminosympathetic pathogenesis was the explanation of the cures "rapidly, sometimes as if miraculously, obtained in these cases." This is one of the reasons why they particularly advocated resection of the end of the middle turbinate which directly affects the sphenopalatine region and its efferent nerves.

Siegrist [23] pointed out that especially the chronic inflammations of the accessory sinuses, associated with the formation of granulations, are apt to give rise to grave diseases of the optic nerve and uvea, rather than the suppurating inflammations of the sinuses.

Stewart [24] reported a case of retrobulbar neuritis in which the patient recovered after evacuation of pus from the sphenoid.

Stocker [25] reported a patient with retrobulbar neuritis who recovered after treatment with Bruning's head light tube. In the discussion, Vogt pointed out that optic neuritis of obscure etiology has often been overestimated in its frequency as an early symptom of multiple sclerosis. A toxic cause is much more probable in obscure cases.

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19. Krassnig, M.: Rhinogenic Retrobulbar Neuritis, Arch. f. Ohren-, Nasen- u. Kehlkopfh. **109**:175, 1922.

20. Leichsenring: Three Cases of Early Evacuation of the Ethmoid in Optic Neuritis, Klin. Wchnschr. **7**:1621, 1928.

21. Meller, J., and Hirsch, O.: Rhinogenic Retrobulbar Neuritis, Abhandl. a. d. Augenh. u. ihr. Grenzgeb; Beihefte z. Ztschr. f. Augenh., 1926, no. 2.

22. Sargnon and Colrat: Contribution to the Study of Ocular Lesions Following Upon Sinusitis, Especially So-Called "Latent" Posterior Sinusitis, Rassegna internaz. di clin. e terap. **8**:698, 1927.

23. Siegrist, A.: Nose and Eye, Schweiz. med. Wchnschr. **7**:681, 1926.

24. Stewart, D. Stenhouse: A Case of Bilateral Sphenoidal Empyema with Mainly Ocular Manifestations, Brit. Ophth. **14**:413, 1928.

25. Stocker, F.: Therapy of Rhinogenic Optic Neuritis, Klin. Monatsbl. f. Augenh. **77**:719, 1926.

Ten Doesschate [26] reported two autopsies in cases of disease of the sinuses. In one, osteomyelitic changes were noted in the bone surrounding the optic nerve. In the other, a purulent infiltration of the sphenoid mucosa was found, extending locally to the dural sheath of the optic nerve.

Thies [27] reported two cases of optic neuritis cured by operation on the ethmoid; little local change was found.

On the basis of his experience, Tommasi [28] believed that when the cause of retrobulbar neuritis is not known, prompt operative procedures are indicated.

White [29] thought that optic neuritis is more frequently caused by the teeth or the tonsils than by the sinuses.

Pichler [30] described various observations in animal experimentation showing the relation of the accessory nasal cavities to the optic nerve. A remote reflex action, by way of the vascular nerves, cannot be assumed to exist. Aseptic corpuscular elements are capable of penetrating through the bony septum between the sinuses and the orbit. Infectious processes require further observations.

Ten Doesschate [31] gave some interesting data observed at autopsy in two cases showing bony changes.

SUMMARY AND CONCLUSIONS

From this brief study of the latest literature, it seems evident that the latent form of sinusitis causing optic neuritis is being rather widely recognized and operation on the sinuses advocated. It is mentioned that the operation is not dangerous with skilled technic. Multiple sclerosis as a cause of retrobulbar neuritis still has its advocates, but in my opinion the cases are by no means well proved, as disease of the sinuses has not been excluded. There seems to be no doubt that the plastic optic neuritis associated with retinal disease is anything

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26. Ten Doesschate, G.: Rhinogenic Lesions of the Optic Nerve, Nederl. Tijdschr. v. Geneesk. **72**:4328, 1928.

27. Thies, O.: The Value of the Roentgen Picture in Rhinogenic Retrobulbar Neuritis, Arch. f. Ophth. **120**:728, 1928.

28. Tommasi, I.: Eye Lesions Due to Latent Suppurative Maxillary Sinusitis and Ethmoido-Sphenoid Sinusitis, Rev. oto-neuro-oft. **4**:428, 1927; Klin. Monatsbl. f. Augenh. **79**:710, 1927.

29. White, L. E.: The Location of the Focus in Optic Nerve Disturbances from Infection, Ann. Otol. Rhin. & Laryng. **37**:128, 1928.

30. Pichler, G.: Investigations on the Problem of Rhinogenic Retrobulbar Neuritis, Monatschr. f. Ohrenh. **63**:120, 1929.

31. Ten Doesschate, G.: Pathologico-Anatomical Findings in Rhinogenic Optic Nerve Affections, Dutch Ophthalmological Society, June 3, 1928, Eye Clinic, University of Leyden.

but toxic. I believe that disease of the optic nerve is a rare complication among the total number of sinus cases, but I am also convinced that it is a most serious condition and one which requires prompt and energetic treatment if a successful result is to be attained. This treatment is, in the vast majority of cases, a complete and thorough operation on the sinuses, as outlined in this article.

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SPHENOIDITIS

VALUE OF CYTOLOGIC STUDIES IN DIAGNOSIS *

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Investigation of the sphenoid sinus is probably more difficult than the study of the other nasal accessory sinuses. This is due to its deep position and to the frequent anatomic obstructions within the nose that prevent its satisfactory exploration. With a clinical history and local physical observations in the nose and throat directing the attention to the posterior group of sinuses, several valuable aids may be employed to establish a diagnosis of sphenoiditis. X-ray studies alone or following the injection of iodized oil give helpful information in diagnosis. A cytologic study of the secretion contained within the sinus is given as an additional valuable method in proving or eliminating the presence of trouble in the sphenoid.

From the x-ray picture one may be able to demonstrate thickening of the mucous membrane, the presence of polypi and, in some cases, the presence of a fluid level of secretion contained within the sinus. An adjacent osteitis secondary to infection of the sphenoid sinus may sometimes be shown, as pointed out by Pfahler.[1]

From the use of iodized oil the size and outline of the sinus can be made out, extensions into the greater wing of the sphenoid bone may be shown and irregularities in the position of the intersinus septum and ridges of the sinus wall may be demonstrated. Any encroachment of the posterior ethmoidal cells into the position normally occupied by the sphenoid sinus may be pointed out. Anderson [2] stated that the normal sphenoid fills completely and smoothly with a scant millimeter between the bone and the oil margin. With this information, thickening of the mucous membrane and the presence of polypi may be determined. Ersner's [3] observation on the use of iodized oil in the maxillary sinus

* Submitted for publication, June 12, 1929.

* From the Oto-Laryngological Department of San Francisco Hospital, Stanford University Service.

1. Pfahler, G. E.: The Radiologic Signs Which Indicate Extension of Infection from the Ethmoid and Sphenoid Sinuses to the Base of the Skull, Tr. Coll. Phys. Phila., Section on Otol. and Laryng., April, 1928.

2. Anderson, H.: The Use of Iodized Oil in the Diagnosis of Nasal Sinus Disease, Arch. Otolaryng. **7**:514 (May) 1928.

3. Ersner, M. S.: Clinical Observations of X-Ray Diagnosis of Maxillary Sinus Disease After the Injection of Iodized Oil and Deductions from the Pathological Report from One Hundred and Fifty Radical Operations on the Maxillary Sinus, Tr. Coll. Phys. Phila., Section on Otol. and Laryng., April, 1928.

was that the normal sinus eliminated the oil in from twenty-four to forty-eight hours. In my experience with injections of iodized oil into the sphenoid cavity, the oil has been eliminated in some cases in less than twenty-four hours. The ability of the ciliated epithelia to eliminate iodized oil may be considered as a rough index of the condition of the lining mucosa. The size of the sinus, however, together with the position and size of the ostium, may be a factor in determining the eliminating time of the iodized oil. A small ostium unfavorably placed or a large ostium favorably placed should and undoubtedly does influence the period of time in which the iodized oil is eliminated.

A practically uncontaminated specimen of material contained within the sphenoid sinus may be obtained for cytologic study by aspiration through the sphenoidal cannula. Probing of the normal ostium and introduction of the sphenoidal cannula is done using Zuckerkandl's line bisecting the middle turbinate as a guide to the ostium. When the normal ostium cannot be located, a graduated trocar with a cannula may be introduced through the anterior sphenoidal wall. The latter method is also of value when there is reason to believe that the secretion is too thick to be drawn through the small lumen of the ordinary sphenoidal cannula. The nasopharyngoscope may be of help in locating the normal ostium when the cannula can be passed through the nose. In fully half of the cases in which a cytologic study of the sphenoid is indicated, obstructions in the nose have been noted that prevented access to the anterior sphenoidal wall. In most of these cases, the correction of the deviated septum or the removal of the hypertrophied middle turbinate or nasal polypi is considered justifiable for a satisfactory study of the sinus.

The advantages of a specimen obtained by aspiration over one obtained by the usual method of collecting the return flow of irrigating fluid through the nose and mouth are evident. Any secretion in the return flow may either have come from the sinus or have been washed out from the nose or throat without indicating its origin. Again, as has been pointed out by Sewall [4] in his study of the maxillary sinus, the sinus may be the seat of trouble and the secretion may be so small in amount as to be apparently soluble in the irrigating fluid. Occasionally a serous variety of secretion may be present, which would entirely escape notice if the ordinary method of sphenoidal irrigation was employed.

The procedure followed in a cytologic study of the aspirated secretion from twenty-five sphenoid sinuses has been as follows: About from 3 to 5 cc. of sterile warm water is introduced through the sphenoidal cannula into the sinus with a Luer syringe. Should the patient

4. Sewall, E. C.: Diagnosis and Treatment of Chronic Maxillary Sinus Infection, Arch. Otolaryng. **8**:405 (Oct.) 1928.

experience the feeling of water running in the back of the throat before the 5 cc. is introduced, further introduction of water is stopped. With the patient's head held slightly forward, the syringe still in place in the cannula, the plunger is withdrawn aspirating the mixture of water and sinus secretion. When the aspirated fluid contains gross pus, a smear on a glass slide can be made direct; if not, the aspirated fluid is centrifugated for five minutes, and the last few drops in the conical centrifuge tube are placed on the glass slide, dried and stained. Frequently aspirated fluid appearing grossly clear may show an appreciable sediment on centrifugation. Methylene blue (methylthionine chloride, U.S.P.) or the Gram stain may be used.

Of the twenty-five cases in which cytologic studies of the aspirated secretion from the sphenoid sinus were made, four contained no cells in the centrifugated specimen, twelve showed a marked preponderance of mononuclear leukocytes, six a preponderance of mononuclear leukocytes with some polymorphonuclear leukocytes in the field, and three a marked preponderance of polymorphonuclear leukocytes. From the clinical history in these cases the following conclusions were reached: The normal healthy sinus contains neither mononuclear nor polymorphonuclear leukocytes in the centrifugated specimen; chronic infections show a preponderance of mononuclear leukocytes, and acute infections show a preponderance of polymorphonuclear cells.

The technic of collection and study of the aspirated secretion from the sphenoid sinus is essentially the same as that employed by Sewall [4] in the study of the maxillary sinus, and the observations made on cytologic study of secretions from these two sinuses are apparently the same.

In considering the observations made on the aspirated secretion from the sphenoid sinus, it should be remembered that one may be dealing with a pyosinus, the sphenoid acting as a reservoir for the collection of discharge from the posterior ethmoidal cells, and the presence of disease primarily in the latter cells must be eliminated. However, with the frequent association of involvement of the sphenoid and posterior ethmoidal cells, the condition observed in the sphenoid may possibly be used as an index of the presence or absence of inflammation in the entire posterior group of sinuses on that side.

In brief consideration of the clinical symptoms of sphenoiditis, the following points are mentioned: Skillern,[5] in his excellent textbook on "Accessory Sinuses of the Nose," stated that the sphenoid is affected more or less during the course of every acute coryza. Many cases undoubtedly clear up with the acute coryza, others persist, with symptoms and local conditions in the nose and throat calling attention to

5. Skillern, R. H.: Accessory Sinuses of the Nose, Philadelphia, J. B. Lippincott Company, 1923, p. 378.

the posterior group of sinuses. These symptoms, as given by most observers, include headache, ocular disturbances and mental symptoms. Headache may be a prominent though an unreliable symptom. This unreliability has been proved when this symptom has been absent, and cytologic studies of the aspirated secretion have shown the presence of inflammation. Retrobulbar neuritis is the commonest of the ocular complications, according to Skillern.[6] The mental symptoms include varying degrees of mental depression, insomnia and, in some cases, suicidal tendencies. The frequency of mental symptoms in sphenoid sinus disease is usually explained as resulting from changes in the brain due to the intimate venous communications between the mucous membrane of the sinus and the dura. Postnasal discharge and chronic pharyngitis are always present in chronic sphenoiditis. The symptom of cough, sometimes prominent in sphenoiditis, is most frequently due to the accompanying pharyngitis and bronchitis. Hay [7] made the suggestion that it is due to irritation of the vidian nerve which runs along the floor of the sinus.

If one bears in mind these clinical symptoms and utilizes the various physical aids at one's disposal, including cytologic study of the sinus secretion, the diagnosis of sphenoiditis and its common associate disease, posterior ethmoiditis, may more easily be made.

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6. Skillern (footnote 6, p. 399).

7. Hay, C. H., cited in discussion of Mithoefer: Acute Sphenoiditis, Ohio State M. J. **23**:296, 1927.

THE PERSISTENCE OF FETAL BLOOD SINUSES AND THEIR RELATION TO THE MIDDLE EAR SPACES*

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It is not often that the persistence of fetal blood channels which are in close relation to the middle ear spaces obtrude themselves on the operator. I dealt recently with such a case, and the results obtained from an extensive investigation are of considerable interest to otologists.

The most frequent and well known of these embryonic veins that survive the changes of development is found in the petrosquamosal blood sinus. As will be seen later, this sinus and also Kelck's accessory blood sinus were present in the case to be recorded. It is not primarily with the petrosquamosal blood sinus that I am here concerned, but with other remains of this same embryonic plexus of veins, which I believe are not infrequently found in the adult skull. The literature on the petrosquamosal blood sinus is fairly extensive. One of the early descriptions of the petrosquamosal blood sinus is found in Quain's[1] "Anatomy," 1892. Clinically, Cleveland,[2] in 1895, recorded a fatal case in which the petrosquamosal blood sinus was the primary focus. In 1899, Cheatle[3] delivered an address to the Sixth International Otological Congress in which he stressed the importance of this blood channel as a medium for infection passing from the middle ear to the brain. Little more was written until Vernieuwe,[4] in 1921, detailed three fatal cases which were due to intermediary infection of this sinus. In some of the most recent textbooks on thrombophlebitis of the cranial blood sinuses, the subject is barely touched on, and then chiefly from historical interest. Kelck's accessory blood sinus has rarely been described and certainly not in the field of otolaryngology. Its presence has been mentioned by Poirier, and, as can be seen from the selection of the following names,

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* From the Ear and Throat Department of the Royal Infirmary, Edinburgh, under the charge of J. S. Fraser, M. B., F.R.C.S.E.

1. Quain: Anatomy, New York, Longmans, Greene & Company, 1892, vol. 11, pt. 2.

2. Cleveland, A. H.: Right Suppurative Otitis Media: Extensive Thrombosis Beginning in the Right Petro-Squamous Sinus: Left Cerebellar Abscess, Arch. Otol. **24**:136, 1895.

3. Cheatle, A. H.: The Petro-Squamous Sinus, Its Anatomy and Pathological Importance, J. Laryngol. Rhinol. & Otol. **15**:13, 1899.

4. Vernieuwe: Les anomalies des sinus de la dure-mère, Rev. de laryngol. **42**:205, 1921.

by other observers. The sinus may be designated as "the aberrant vein of Verga," "the accessory sinus of Kelck" and "the ophthalmopetrous sinus of Hyrtl;" Wood Jones also described it. It is difficult to find even the name of the petro-occipital blood sinus in the standard textbooks on anatomy in this country. Englische, of Vienna, discovered its presence, and Poirier [5] gave a good description of it in his textbook.

Before considering this subject in detail, it would be well to record the case from which this research originated.

REPORT OF CASE

History.—F. L., a woman, aged 51, was first seen on April 15, 1929, when she gave a history of pain and discharge from the right ear for one month. She denied any previous aural trouble. The pain kept her awake on the night before her admission to the hospital. She attended as an outpatient until April 18, when she was admitted to the wards of the Royal Infirmary, Edinburgh.

Examination.—At the time of admission, the left drumhead was found to be normal. In the right drumhead there was a large anterior perforation with rolled edges, from which there was a pulsating purulent discharge. There was no tenderness of the mastoid on the right side, although the patient complained of pain in the ear, which radiated over the right frontal and parietal regions. Roentgen examination showed the mastoid process to be diploic. Little comparative difference was present in roentgenograms of the two mastoids.

Operation.—On April 19, it was decided to perform the simple mastoid operation, and if necessary to proceed to perform the complete radical operation. The history pointed to an acute case and the local and roentgen appearances to a chronic case. At 8 p. m., an incision was made as for a Schwartze operation: the superficial tissues and the cortex were normal. The first blow of the gouge exposed the sigmoid sinus lying far forward and running obliquely across the mastoid process. Direct access to the antrum was thus blocked, so that the posterior meatal wall was removed and the antrum was opened up by this route. The antrum then was lying medial to the sigmoid sinus. Koerner's meatal flap was cut at this stage. The tympanic antrum was found to be dilated and filled with granulations. Both ossicles were removed, and the attic was opened; the facial spur was lowered, and the eustachian tube was curetted. It was noted that when the largest size curet was introduced, a slight crack was felt, and on withdrawal of the instrument, a little ooze of venous blood followed from the orifice of the tube. This soon stopped. The posterior wound was stitched, and the operative cavity was packed with iodoform worsted.

Course.—On April 20, the patient still complained of pain radiating from the frontal region over the parietes; otherwise, she was comfortable. She could hear with the noise box in the good ear and had no nystagmus. At 3 p. m., the temperature rose to 99 F.; at 7 p. m., to 100 F., and at 11 p. m. to 100.5 F. She did not complain. During the afternoon, she chatted with her husband, who thought she was well, and in this spirit he left her to go to a football match.

On April 21, at 3 a. m., the night nurse noticed that the patient's right eye was swollen and that the temperature had gone up to 103 F. At 9 a. m., the

5. Poirier, Paul: Traite d'anatomie humaine, Paris, Masson & Cie, 1898, vol. 11, no. 3, p. 974.

temperature was 98 F., and the patient was conscious. Examination of the patient showed protrusion of the right eyeball, which was fixed. The conjunctiva was slightly injected and extremely edematous; the pupils were contracted, but on comparison with the sound side were found to be equal. Ptosis was present, and the patient was blind in the right eye. The whole right side of the face was tense with edema. It was also noticed that the tissues overlying the temporal region and the tissues on the right side of the nasal and oral pharynx were very swollen. The wound in the mastoid was examined and found satisfactory. At 11 a. m., the temperature rose to 101.2 F., and the patient became cyanosed. At 2 p. m., the patient sank into unconsciousness, and the pupils became dilated. An ophthalmic surgeon saw the patient at this stage. It was impossible to draw up the right eyelid owing to the intense swelling. The veins of the left eye showed fulness. At 3 p. m., the temperature fell slightly, to 100.2 F., and the patient died. Death occurred exactly forty-three hours after the operation and twelve hours after the first visible symptoms of the intracranial lesion.

Postmortem Examination.—The tissues in the region of the right eyebrow were somewhat swollen. The right temporal muscle was very edematous, and some hemorrhage had occurred into it. On the extradural surface on the right side there were numerous minute hemorrhages. When the dura was separated from the brain, small areas of pus were present over the right temporal lobe, particularly toward the anterior pole. There were also numerous hemorrhages in this region, which were apparently toxic in origin. The surface of the dura in the middle fossa on the right side was hemorrhagic and congested, and there were small areas of pus. When the cavernous sinus was opened on the right side, it was seen to be filled with pale reddish blood which had all the appearances of early septic thrombus formation. There was also early septic thrombus formation in the sigmoid and in the transverse sinus on the right side. The superior and inferior petrosal blood sinuses contained the same material as that in the cavernous sinus.

The region of the sella turcica was markedly hemorrhagic and congested. This hemorrhage and congestion had spread over the surface of the pituitary and into the pituitary gland.

The sphenoidal sinus was opened and, except for some congestion of the mucous membrane, was found to be healthy. The upper part of the nasal cavity was opened through the cribriform plate, and here again no evidence of inflammation could be seen. The labyrinth was opened on both sides and was found to be healthy.

On further examination, a small fracture was discovered in the roof of the eustachian canal, and running alongside there was a small blood sinus which opened in front into the cavernous sinus and behind into the superior petrosal sinus. The contents of this sinus were similar to those found in the cavernous sinus, namely, a septic thrombus. Another blood sinus was located running along the inferior or extracranial surface of the petro-occipital suture. This sinus was also filled with a septic blood clot. The orbit on the right side was investigated, and the orbital muscles were seen to be infiltrated with blood and edematous. No evidence of pus could be seen.

On examination of the brain, no generalized leptomeningitis was present; on section of the cerebral hemispheres, no evidence of abscess formation was found. There was nothing to note on section of the cerebellum, the pons or the medulla.

Bacteriologic Report on Cultures Taken from the Brain and Cavernous Sinus.—Direct films showed gram-positive cocci, singly and in pairs, and cultures gave a growth of *Staphylococcus aureus.*

DEVELOPMENT OF THE CRANIAL BLOOD SINUSES

The three abnormal venous sinuses that were encountered were as follows: (1) petrosquamosal blood sinus, (2) accessory blood sinus of Kelck and (3) petro-occipital blood sinus. Each of these will be considered separately after I have sketched briefly the development of the cranial blood sinuses.

The question arises as to the origin of these abnormal veins. In order to answer this, it is necessary to consider the embryologic aspect of the subject. The fetal venous circulation originates as a channel, conveying the blood from the yolk sac to the heart. This is known as the omphalomesenteric vein. Shortly after this, the primary body veins become formed. They lie in two main groups, one on either side of the aorta. The portion of this trunk lying above the heart is termed the anterior cardinal vein, while that below is named the posterior cardinal vein.

I am here concerned with the anterior cardinal veins that collect the blood from the head and neck. In the skull they lie on the medial side of the roots of the cranial nerves. After a time collaterals shoot out from the veins and pass to the lateral side of the roots of the cranial nerves, and in the course of development form a single vein so much larger than the one from which they sprang that it now forms the main channel. The veins lying on the medial side of the roots of the cranial nerve atrophy, except in the region of the trigeminal nerve, where they continue to develop and ultimately form the cavernous sinus.

This main lateral blood channel is now termed the lateral vein of the head. It leaves the skull by a channel in front of the ear (which is subsequently obliterated) to drain into the primitive jugular vein. (The external jugular vein is a derivative of this primitive vein, which becomes atrophied on the formation of the internal jugular vein.) The arrangement which I have just described is only temporary, as in the normal skull at birth it is completely absent. When one finds this primitive arrangement present in the fully formed skull, one terms what was the lateral vein of the head, the petrosquamosal blood sinus. The accessory blood sinus of Kelck is a persistence of a collateral offshoot from the anterior cardinal veins which lie medially to the cranial nerve roots. The petro-occipital blood sinus is probably a derivative of the inferior cerebral vein, another fetal structure.

Petrosquamosal Sinus.—Knott [6] described the course of this sinus thus:

> This small vessel when present occupies the angle between the petrous and squamous portions of the temporal bone and opens (inside the skull) into the

6. Knott, J. F.: On the Cerebral Sinuses and Their Variations, J. Anat. **16**:27, 1882.

lateral sinus after crossing the posterior extremity of the superior border of the petrous bone or passing through a canal in the latter. In front it pierces the squamous portion of the temporal bone, a little above the root of the zygomatic process or perhaps the latter process itself, to communicate with the deep temporal veins.

The sinus may also reach the outside of the skull by way of the foramen jugulare spurium, the foramen spinosum or by the mastoid foramen.

This sinus is normally found in the lower animals, e.g., in the dog. In the case presented, the petrosquamosal sinus was present and thrombosed. Posteriorly, it joined with the superior petrosal sinus to form a common entry into the descending portion of the lateral sinus. Anteriorly, it anastomosed with one of the middle meningeal veins, and there were also the remains of a foramen in the squama just above the posterior root of the zygoma which obviously transmitted this vessel before its incomplete obliteration.

Accessory Sinus of Kelck.—This vein was the primary source of the infection. Poirier described it as running from the ophthalmic veins to the superior petrosal blood sinus. Wood Jones [7] detailed it as follows:

I have also frequently noted the presence of a large vein which runs in an antero-posterior direction superficial to the semilunar ganglion, parallel to the cavernous sinus. This vein, as a rule, joins the superior petrosal blood sinus behind, and in front it is continuous with the meningeal sinuses or the ophthalmic veins.

A more detailed description of this vein is given in a thesis on the "meningeal veins" by L. Becker, presented for the degree of Doctor of Medicine of Edinburgh University. He was struck with the remarkable frequency with which he found evidence of this vessel. Of thirty-one skulls examined, he found the channel present in twenty-three instances (sixteen skulls showed it on both sides and the remaining seven showed it only on the left side). In addition to the posterior termination already mentioned, the accessory blood sinus may pass through the hiatus canalis facialis. This hiatus normally transmits the petrous branches (artery and vein) from the middle meningeal vessels. In the case under consideration, this vein at its anterior extremity passed into the bony carotid canal at the apex of the petrous bone, and then continued separately or conjointly with the carotid venous plexus to end ultimately in the cavernous sinus. Posteriorly, it communicated with both the hiatus canalis facialis and the superior petrosal blood sinus. Thus, I have demonstrated still another termination of the accessory blood sinus of Kelck.

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7. Wood Jones, F.: On the Grooves upon the Ossa Perietellia, Commonly Said to Be Caused by the Arteria Meningea Media, J. Anat. & Physiol. **7**:228, 1912.

Petro-Occipital Sinus.—This sinus is the only one of its kind to be situated outside the cranial cavity. It runs extracranially along the inferior surface of the petro-occipital suture and, therefore, is embedded to a slight extent in cartilage. Anteriorly, it traverses an opening in this suture near the apex of the petrous bone, and becomes continuous with the carotid venous plexus at the point where the latter enters the cavernous sinus proper. Posteriorly the sinus drains into the jugular bulb, where it is in close relation with the inferior petrosal sinus.

This petro-occipital blood sinus receives veins from the pharynx and emissaries from the cavernous blood sinus. The tributaries from the pharyngeal veins explain the swelling of the right side of the pharynx seen clinically in this case.

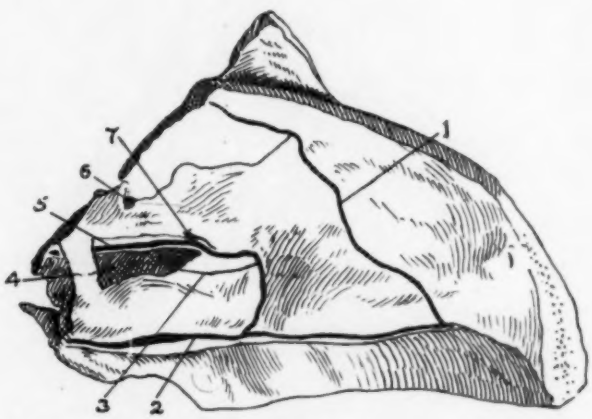

Fig. 1.—Right temporal bone (superior surface). *1*, petrosquamous sinus; *2*, superior petrosal sinus; *3*, groove for greater superficial petrosal nerve; *4*, carotid canal showing absence of roof; *5*, Kelck's accessory sinus; *6*, foramen spinosum; *7*, fracture of roof of eustachian tube.

THE RIGHT TEMPORAL BONE

For the sake of convenience rather than preciseness, I shall divide the bone into four surfaces (superior, inferior, lateral and medial) and shall detail each one separately.

Superior Surface.—At the extreme anterior end of the petrous bone the bony carotid canal was complete, but extending backward from this point the bony roof of the carotid canal was absent (fig. 1, *4*). One could see plainly into the descending portion of this canal. Extending along the lateral side of the carotid canal and the roof of the eustachian tube there was a groove which contained Kelck's accessory blood sinus (fig. 1, *5*). Anteriorly where the bony carotid canal was complete, the sinus dipped down and entered this canal, at the extreme end of the congenital gap. It ran either separately or conjointly with the carotid venous plexus to enter the cavernous sinus. Posteriorly, the accessory blood sinus bent

sharply mediaward just at the hiatus canalis facialis, where it gave off a branch, and then continued onward to join the superior petrosal sinus (fig. 1, *2*) at right angles. The groove was distinct from that transmitting the greater superficial petrosal nerve (fig. 1, *3*).

There was a small fracture in the roof of the eustachian tube about the medial point of the horizontal portion of the carotid canal and involving the groove for the accessory blood sinus (fig. 1, *7*). Running along the petrosquamous suture was the corresponding sinus (fig. 1, *1*). Anteriorly it anastomosed with the middle meningeal veins, while posteriorly it joined the superior petrosal sinus to form a common opening into the sigmoid sinus. There was a small cleft in the bone at this junction.

Inferior Surface.—There was a venous sinus running along the under surface of the petro-occipital suture (fig. 2, *1*). This sinus communicated below directly

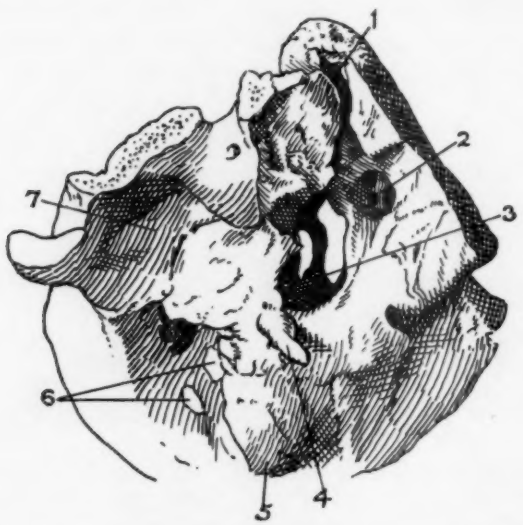

Fig. 2.—Right temporal bone (inferior surface). *1*, petro-occipital sinus; *2*, irregular bony formation within the posterior condylar canal; *3*, jugular bulb showing gaps in the bone; *4*, styloid process; *5*, tip of mastoid process; *6*, bone removed over sigmoid sinus at operation; *7*, glenoid fossa.

with the jugular bulb (fig. 2, *3*) and above it ran into the carotid canal at about the same level as Kelck's accessory sinus. This sinus was identical with the inferior petrosal sinus, and might also be described as a duplicate of the latter.

The ascending portion of the carotid canal was complete. The eustachian tube was somewhat smaller than normal. A fine probe could be passed through it with difficulty. The bony floor of the middle ear was deficient over the region of the jugular bulb.

Lateral Surface.—There was a foramen which extended into the substance of the bone for about 1 mm., just above the posterior root of the zygoma. From the direction of the canal, if its lumen were continued onward, it would meet the petrosquamosal sinus. These were the remains of the original outlet (fig. 3, *1*).

The cavity from the radical operation on the mastoid was seen, and also two spaces in the wall of the sigmoid sinus where the bone was removed at operation (fig. 3, *4*).

Medial Surface.—The groove for the inferior petrosal sinus was deeply indented. There was a large foramen that connected this groove with the carotid canal. It would seem that the greater bulk of blood running into this sinus must have issued from the carotid canal (fig. 4, *6*).

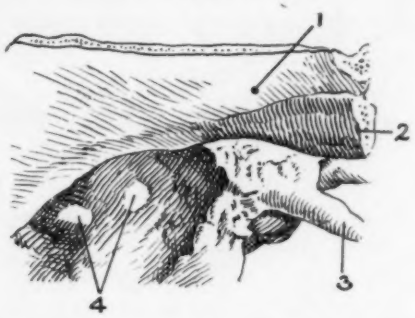

Fig. 3.—Right temporal bone (lateral surface). *1*, remains of foramen for the petrosquamosal sinus; *2*, posterior root of zygoma; *3*, styloid process; *4*, bone removed over sigmoid sinus at operation.

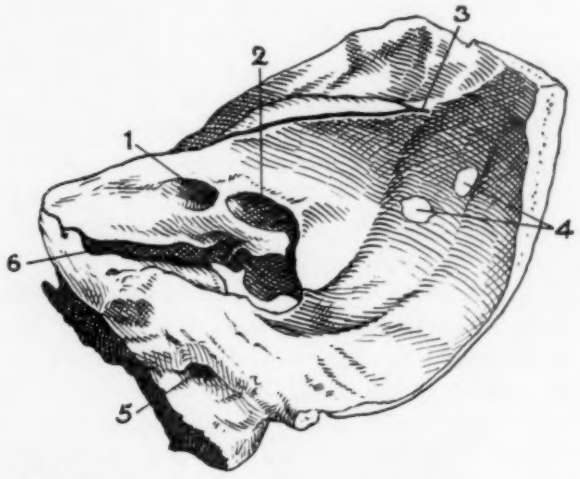

Fig. 4.—Right temporal bone (medial surface). *1*, internal acoustic meatus; *2*, bulb of internal jugular vein showing congenital absences in the bone; *3*, junction of petrosquamosal and superior petrosal sinuses at point of entry into sigmoid sinus; *4*, bone removed over sigmoid sinus at operation; *5*, posterior condylar foramen; *6*, inferior petrosal sinus. (Note that the main depth is carried inward through the foramen into the carotid canal.)

The bulb of the jugular vein was situated high (fig. 4, *2*) and on a level with the floor of the internal auditory meatus (fig. 4, *1*), while its bony covering was deficient in places. The intrajugular process was prominent.

Thus, radiating out of the carotid canal there were the following blood channels: a branch of the inferior petrosal sinus, the petro-occipital sinus and Kelck's accessory sinus.

The absence of most of the roof of the horizontal portion of the carotid canal, the high position and the dehiscences in the bony roof of the jugular bulb and the persistence of three of the embryonic blood sinuses indicated the fetal type of temporal bone.

The fracture in the roof of the eustachian canal was due to disproportion between the size of the curet and the lumen of the canal.

CONCLUSIONS

I was first struck with the severity and the rapid lethal termination of this illness. Presumably, this accessory sinus of Kelck was primarily infected at operation by the fracture of the roof of the bony portion of the eustachian tube and the injury to this sinus. Assuming this to be the case, death ensued in forty-three hours.

The first symptom, apart from the slight rise in temperature which occurred nineteen hours after operation, appeared twelve hours before death. In such a case, the condition might be termed a malignant or fulminating thrombophlebitis.

The unilateral distribution of the swelling and symptoms demonstrated the rapidity of the end. If the case had lasted longer, these appearances must have become bilateral. It is interesting that half an hour before death the oculist found only some fulness of the ophthalmic veins on the left side (unaffected side).

The actual duration of the illness is not stated by Vernieuwe in his three cases, but one can gather that it was only a matter of two or three days before death supervened. The symptoms in the case presented were due to sudden venous obstruction, and regionally can be readily accounted for if the drainage areas of the affected sinuses are recalled.

The unilateral swelling of the pharynx is of great interest as its presence depends on the existence of the petro-occipital sinus.

Vernieuwe described three cases of thrombophlebitis of the petrosquamous sinus which ended fatally, enumerating the following symptoms as likely to prove valuable in the diagnosis of such a condition: (*a*) diffuse edema in the temporal region, which in his opinion constitutes the clinical sign above all others that is to be relied on; (*b*) frontal pains which follow rapidly the phenomena of optic stasis and (*c*) ocular stasis. At the postmortem examination, I was astonished at the immense edema of the right temporal muscle. This edema was produced secondarily to the involvement of the pterygoid plexus, which drains the deep temporal veins running from the temporal fossa.

The facial paralysis was either a true paralysis or a pseudoparalysis. If it was the latter, it was due to mechanical causes, such as the intense edema of the face. On the other hand, Kelck's sinus communicated with

the hiatus canalis facialis, and it is not unreasonable to suppose that there was a downward spread of the infection to the geniculate ganglion and main trunk of the facial nerve.

The infecting organism was *Staphylococcus aureus,* which is a common inhabitant of the middle ear during chronic suppurations. It seldom is important enough to do much mischief in the ear, and it is only in a case such as the one presented that it does so. Ophthalmic surgeons state that *Staphylococcus aureus* is a contraindication to operation.

Probably this is the first time that this abnormal cranial blood sinus, named after Kelck, has been considered (and also encountered) as a pathway of infection from the middle ear to the cranial structures. Infection of this sinus may explain some of those cases of meningitis which physicians in their ignorance attribute to a general blood infection. Such cases rapidly follow acute suppurative otitis media without involvement of the mastoid. There is no doubt that there is a large field for further research on this subject.

THE USE OF ENDOTHERMY IN LARYNGOLOGY*

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Cushing [1] has said, "Surgery is a conservative art. It takes to novel methods reluctantly as an old dog to new tricks. It was slow to adopt the ligature; slow to adopt the principles of antisepsis; slow to adopt the fastidious technique and painstaking haemostasis that have largely put a stop to operating by the clock. It has been equally slow to adopt the principles of electro-surgery which, from a technical standpoint, are likely to be no less revolutionizing."

The term electrosurgery is a fortunate choice in that it does away with such phrases as surgical diathermy or endothermy, which to the nonelectrical mind are, to say the least, vaguely disturbing and mysterious. Electricity and some of its manifestations and uses are more or less familiar. One is able to comprehend, to some extent, what electrosurgery might include, while one is immediately lost in a haze of skepticism and mystery when confronted with such terms as diathermy and endothermy. Electrodesiccation and electro-coagulation mean something, although their application may still be a mystery.

Nearly twenty years have passed since Pozzi announced to the Academy of Medicine in Paris a method for the cure of malignancy by the action of sparks from the terminal of an Oudinesinator, a procedure termed "fulguration." Slowly and gradually there has evolved from the original contribution at least two other electrical phenomena, first a coagulating current, otherwise known as the d'Arsonval current, and second the knife or cutting current. The Oudin current or fulguration is now more familiarly known as the desiccating current.

The surgeon need not be expected to know the full details of the electrothermic principles which are involved, though he should have some familiarity with them if he is to do more than merely run the machine.

Dr. Bovie [1] stated, "Comparatively large amounts of an alternating current, if the frequency of the alternations is sufficiently high, can be passed through the tissues without producing any physiological effect other than that of heating. The amount of heat developed by a high-frequency current is proportional to the square of the current density."

In electrosurgery, a high current density is obtained by making the active (operating) electrode small, whereas the inactive (indifferent)

* Submitted for publication, June 12, 1929.

1. Cushing, Harvey, and Bovie, W. T.: Electro-Surgery as Aid to Removal of Intracranial Tumors, Surg. Gynec. Obst. **47**:751 (Dec.) 1928.

electrode, through which the electrical circuit between the patient and machine is completed, is made large so that the current density in its immediate vicinity will be sufficiently low to permit the small amount of heat developed to be readily dissipated by the blood stream.

The physical principles involved are complicated, since the currents used change their direction of flow from one to three million times per second and distribute themselves in the electrical circuits in a manner different from that of steady currents or alternating currents of far lower frequency. Thus the simple relations between voltage and amperage which hold for steady currents and for alternating currents of lower frequency are upset by what the physicists term "phase shifts."

For laryngologists' purposes, it will be much better to define the currents in terms of the effects which they produce on the tissues. There are three distinct ways in which the various high frequency currents delivered by the machine are used in electrosurgery: (1) superficial dehydration or desiccation; (2) cutting and (3) tissue coagulation.

1. For superficial dehydration the Oudin current is used. The active electrode is held, not in actual contact with, but sufficiently close to, the tissues to be dehydrated, so that sparks are sprayed across the intervening space. The high temperature of the sparks is sufficient to dehydrate completely a thin outer layer of tissue.

In practice this current is satisfactory when the space is sufficient to guard against injury to the adjacent tissues. In laryngologic work, and I shall confine myself strictly to this field, this current may be used in the supraglottic space and on the upper surfaces of the cords. In the treatment of lesions on the median border and inferior surface of one cord, however, one frequently finds it impossible to retract the opposite cord sufficiently to protect it from the spark. In this situation there is recourse to the coagulating current. It has been found that by reducing the current and spark gap as low as possible and by touching the point to be coagulated lightly with the electrode, a reaction in the tissues takes place similar to that brought about by the desiccating current.

2. For cutting purposes, the active electrode is energized by a different type of current. The cutting is done not by the electrode, which has no sharpened edge, but actually by the current which forms ahead of the electrode an electrical arc which by volatilizing the tissues separates them as though they were cut. Further, by a suitable modification of the same current a greater or lesser degree of coagulation or dehydration may be produced at will at the edges of the severed tissues. When the tissues are not particularly vascular, the current is so modified as to produce the minimum amount of dehydration, but when the blood supply is greater, the amount of dehydration is correspondingly increased.

3. For heating the tissues en masse, electro-coagulation, the kind of current differs widely from that employed for cutting. An electrode energized with coagulating currents instead of having cutting properties cannot be moved through the tissues. The tissues surrounding the electrode become heated to a depth depending on two factors, the density of the current and the length of time it is permitted to flow. If a large tissue mass is to be coagulated, a comparatively weak current must be used for a prolonged period, until it becomes heated throughout. For should a stronger current be used, the tissues in the immediate vicinity of the active electrode would become so quickly dehydrated or even carbonized that the current would cease to flow, and the deeper tissues would not be affected.

Perhaps laryngologists have been particularly hesitant in applying such revolutionary measures to their particular field, although the use of the actual cautery is familiar to all. For years the destruction of pathologic tissue in the larynx has been attempted by the use of various escharotics such as silver nitrate, trichloracetic acid, acid nitrate of mercury, etc., chemicals which have had to be used with extreme care in order to avoid a deforming cicatrix.

From experience gained through the use of electrosurgery in the more accessible tissues of the body, it has been more and more evident that one has at his command an extremely fluid medium with which to accomplish his purpose. Electrical currents are under control which may be used to desiccate lightly areas no larger than the head of a common pin or produce a massive coagulation of a large tumor. The thin, soft, pliable and elastic scar which is left is perhaps as near the ideal as one may ever hope to attain. Particularly is this true on mucous membranes when frequently the scar is not visible.

PROCEDURE

Anesthesia may be either local or general. When the lesion to be treated is well above the cords, local anesthesia with exposure of the larynx by the laryngoscope is the method of choice. As each application of the current does not exceed a few seconds—five to ten—the procedure is easily borne by the patient. Whenever possible, the Mosher laryngoscope is preferable to the Jackson, for the reason that the open side allows the electrode to be introduced at an angle and therefore to be more accurately placed.

General anesthesia is preferable for the treatment of lesion of the cords. In conjunction with this the Lynch suspension is a sine qua non. It requires all the skill which one can muster to apply properly the electrode to the edge or inferior border of one cord while properly retracting and protecting the other. Mention has already been made of a weak coagulating current in place of the desiccating current in this situation.

The danger of ether explosion seems to be entirely obviated by the complete removal of all ether from the vicinity of the patient and a waiting of at least three minutes before proceeding with the application of the current.

Electrodes must be of a suitable length for the endolaryngeal approach. The scarcity of suitable electrodes for this work emphasizes sufficiently the lack of interest in this procedure on the part of laryngologists. The usual types, such as the needle point or a small flat blade, can be readily used. The ordinary wire loop will be found suitable for the larger areas of the supraglottic space. The ordinary laryngeal snare, suitably insulated, has also been of value.

The one outstanding advantage of the method is the soft, pliable elastic scar which results—a scar with little if any surrounding fibrous tissue. Indeed, it has been pointed out that in the treatment of laryngeal tuberculosis this method is not efficacious as the use of actual cautery because it does not form the dense fibrous tissue which isolates the bacteria. The enormous advantage of this peculiarity in so delicate a structure as the larynx can be readily appreciated.

There is an exceedingly fluid medium by which any degree of desiccation of coagulation desired can be obtained. As is true in all surgical procedures, one must become intimately acquainted with the tools to be used. This requires practice. For the same reason that one practices with a dummy safety pin before attempting the removal of the actual pin from the bronchus, so in delicate laryngeal work one must test out electrodes and currents on a piece of tissue, such as raw beef, before applying them.

INDICATIONS

Malignant Disease.—As the first indication for the use of electrosurgery was seen in malignant disease, a large part of the literature concerns this subject. What of its use in malignant conditions of the larynx? In operable intrinsic cancer of the larynx, a place can hardly be assigned to electrosurgery, in view of the results obtained by Sir St. Clair Thomson and Dr. McKenty, by laryngofissure and laryngectomy, respectively, and by others following in their footsteps.

In inoperable or extrinsic cancer a certain amount can safely be done to alleviate suffering. I recall the case of one patient who suffered greatly from dysphagia due to an enormously enlarged and infiltrated epiglottis. It was a comparatively simple matter to remove this under suspension by the use of the ordinary wire snare through which was placed a cutting current. The tremendous relief experienced by the patient assuredly justified a procedure which would have been approached with many misgivings under other conditions.

I am sure that every surgeon has earnestly hoped that he would never again be confronted with the necessity of performing a tracheotomy in tissues infiltrated with cancer. After watching a colleague, Dr. W. Edwards Herman, perform a practically bloodless tracheotomy under such conditions, I would commend it for consideration. This suggests the possible use of the method for performing tracheotomy in phlegmon of the neck also.

It is hoped that the narrow line between operable and inoperable cancer of the larynx may be broadened by further experience. Instances have already been reported in which patients with seemingly hopeless cases have experienced prolonged life and comfort by the use of electrosurgery.

Further experience may have much to do in deciding the much mooted question of biopsy.

Angioma.—The results obtained from the use of electrosurgery in angioma in the nose are encouraging for its use in the larynx. Angioma is a rare tumor of the larynx, and no report on one so treated has been found.

Cysts.—A report of a case will serve to illustrate the advantages of the method.

Mrs. C. H., aged 52, complained of hoarseness and a sensation of fulness in the larynx for eighteen months. Examination revealed two small cysts, one on the anterior surface of each arytenoid and well above the cords. These were removed under suspension, and the bases were cauterized with silver nitrate 50 per cent. The growths recurred in three weeks. They were again removed and the bases were cauterized with trichloracetic acid. Recurrence took place in four weeks. They were removed a third time, and the bases were desiccated by the unipolar method. There was no recurrence and no scar is visible.

Cysts in general require the removal or destruction of the entire secreting membrane. The complete removal of the broad bases of these two cysts would have necessitated the dissecting out of considerable mucous membrane and the consequent exposure of the arytenoid cartilage. Granting that one had the skill to so remove them, the resulting wound would have been troublesome. There is no question but that with sufficient practice the escharotic effect of the electric current can be much more easily controlled than is the case with the usual escharotics.

Varix of the Vocal Cord.—In the treatment of varix of the cord the results are eminently satisfactory, an invisible scar remaining. The constant danger of injuring the cord in the attempt to grasp a small varix is obviated.

Papilloma.—The reported results of the treatment of papilloma of the larynx by electrosurgery vary greatly. Portman and Moreau [2] quoted Bourgeos and Poyet as stating that the results are poor in infants and variable in adults. Five years ago Dr. Hubbard and Galbraith presented a series of cases of papillomas of the larynx in which the patients were treated by "fulgeration and diathermy." Their results were splendid; however, the discussions following the presentation were discouraging, to say the least.

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2. Portman, Georges, and Moreau, Noel: Acta oto-laryng. **7**:471, 1925.

It is well known that papillomas are easily transplanted in normal tissues and almost invariably recur.

An attempt is made to accomplish three ends: (1) the prevention of transplantation of the tissue into normal tissue, (2) the removal of the tissue and (3) the prevention of a recurrence.

First attempts at desiccation or coagulation en masse to gain the first two ends, that is, avoidance of transplants and removal of this tissue, did not always prevent recurrences. The difficulty seemed to be in judging the amount of current necessary for the complete destruction of the masse itself and the base in particular. It was observed that when the base was sufficiently desiccated, there was no recurrence. There followed the removal of the tissue by instrumentation with direct desiccation of the base. The results from this procedure were much more satisfactory. Recurrences, if any, were on the edge of the scar, where the desiccation had not been carried widely enough, or on the edge and inferior surface of the cord where the difficulties of exposure and fear of injury to the opposite cord resulted in a conservative procedure.

The danger of transplants can be obviated to some extent by coagulation of the tissue before its instrumental removal.

Attention is particularly called to the importance of exposing the base of the mass that it may be sufficiently desiccated under direct vision. The desiccation should be begun well beyond the outer edge of the base and then carried inward to the median line. The scar often is not evident without touching the cord when a wrinkle of the upper surface can be seen.

THE PSYCHOLOGIST'S INTEREST IN HEARING*

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In the modern sciences of life the living organism has gradually revealed a greater and greater complexity—a complexity of substance as well as of function. So complicated have the body and its operations become that all who delve into its fascinating intricacies are inclined to alternate between the ardent enthusiasm of the explorer and the bewildered doubt of the lost traveler. One has not far to seek for the terms of this growing complexity. There is scarcely an aspect or phase of life, from fertilization to death, from the structure of protoplasm to the details of glandular function, which does not reveal new subtleties. The cell itself has grown enormously complex within. While it still maintains its structural integrity and its genetic significance, the physiologist and the geneticist are now compelled to penetrate the great interacting systems of nucleus and cytoplasm. Specific enzymes by the hundred are assumed to account for the processes of digestion and dozens of new harmonic regulators to explain the chemical integration of the body. Everywhere there is increasing complexity in structure, in process and in agency. In the sciences of life problems seem, therefore, to approach solution not so much by the discovery of new simplicities as by the revelation of new but enlightening subtleties.

Hearing is but a special case of the general trend. In his first edition of the great *Lehre von den Tonempfindungen* in 1863, Helmholtz was able to give a simple, straightforward and lucid account of the ear and of hearing, an account which every intelligent reader could understand, which stood almost unchallenged for decades, and which has of late been called in question only because an extraordinary complication has appeared in the facts of structure, of function and of the auditory experiences themselves.

Owing to his masterly grasp of fundamental problems, as well as to the relatively simple state of acoustic knowledge of his time, Helmholtz could declare that the ear consisted of a sound-conducting mechanism and of a graded set of discrete and selective resonators set in mechanical contact with nerve fibers. He could further declare that sounds consisted of tones and noises, that tones were produced by periodic wave-

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trains which stimulated local resonators and noises by aperiodic vibrations which more generally affected the sensory fibers. Loudness was caused by the energy of the physical disturbance in the ear. This was all except for details. The report was simple and almost entirely satisfactory. Complications, however, have arisen from every side. The physicist found that he could not make a satisfactory model of Helmholtz's sympathetically resonating ear; the embryologist could not derive it; the neurologist tangled his feet in new facts of conduction; the pathologist could not satisfactorily explain his diseases, and the psychologist found the experience of hearing much too involved for so simple a reduction. It has finally come to be realized that only a rational division of labor and an intelligent method of cooperation will disentangle the rapidly growing complications and will seriously advance the knowledge of auditory phenomena and supply competent care for aural defect and disorder. It is the general recognition of these related principles of division and cooperation that is advancing the biologic, the medical and the psychologic research of the present day; it is a special exemplification of them which has brought me an invitation to represent a subject which would have seemed, not many years ago, to be alien to the problems and wholly foreign to the interests of the otologist.

THE NECESSITY FOR A COMMON UNDERSTANDING

To find common ground and a common language is still not easy. In my case the attempt appears possible only because I have many times during the past ten years sat at the counsel table with the president of this society and with other otologists and have likewise engaged with physicist, physiologist, embryologist and the zoological student of life in fruitful discussions of common problems concerning the inner ear, its function and its disorders.

It is said that in ancient Egypt the physicians met and agreed to lay off the body of the patient into blocks and parcels, each medical trade to be responsible for its carefully partitioned fragment. At the appearance of local symptoms, then, the patient was sent around from specialist to specialist, taking his medicines and paying his tolls until he was cured, exhausted by the journey or killed. Such a piecemeal division and such a puzzle-block reconstruction will not serve here. It would be foolish for me to introduce as a separate entity the hearing mind; the otologist, the suppurating tympanum or the sclerotic tissue; the embryologist, his otic vesicle and its derivatives; the physicist, his partitioned alleys and the basilar string-board; the neurologist, his hair cells and nerve fibers; the histologist, his microscopic preparations; the anatomist, his temporal bone and embedded structures; the engineer, his working models and networks; the hygienist, his rules for preserving the acoustic

functions, and the teacher, his methods of instructing auditorily defective subjects. Each one must somehow view the common problem of hearing, and then each make his own focus and margin, select his own points of emphasis, approach the common problem from his own standpoint and use his own special training to advance a common project. Only thus, so far as I can see, can we envisage our several tasks and make our several contributions.

Thus understood, I should like to make clear—so far as my ignorance of otological arts and practices will permit—the nature of the interest which the psychologist sustains in hearing.

As with the otologist, the psychologist's interest lies in the living organism. And so much does he hold in common also with morphologist, physiologist, physicist, comparative anatomist and student of development. All are concerned with the aural resources of the organism and with the functions and accomplishments of hearing. The particular focus of the psychologist, however, is set on the experience of hearing sounds. That experience he wishes to describe and to understand. Whatever he may ultimately think about mind, consciousness or behavior, those matters do not enter here where he is concerned only with what the organism hears and how it hears. Within the focus of the otologist (if I may—for the sake of a useful distinction—presume to touch on matters beyond my knowledge) appears the disturbance of hearing, especially as disturbance implies pathologic and involutional processes and conditions. Moreover, the otologist assumes a responsibility for relief and for functional improvement of the organism which the psychologist does not share.

Let us ask the psychologist at once how he approaches his experience of hearing and how he proposes to use the knowledge of physics, physiology, neurology and the rest to advance his problems.

The matters pertaining especially to the psychologist may be considered under four main headings: (1) a description of the simpler auditory experiences; (2) the relation of these experiences to the forms of energy delivered to the cochlea; (3) the relation of them also to aural structures and mechanisms, and (4) an account of various more complex auditory phenomena (combination tones, intermediate tones, beats, fusions, consonance, the octave quality, binaural synergies and special localization).

THE SIMPLER AUDITORY EXPERIENCES

What are the simpler sounds? From the psychologist's point of view, no real headway can be made until it is known what sounds are; by "sounds" are meant what the organism actually hears and not physical vibration. Consequently, one begins as simply as possible by interrogating the organism as to what, in plain terms, it experiences when it uses its ears. One good reason for beginning with the simpler

sounds is that the ear is an analyzing apparatus which distinguishes (with certain limitations) the components of a complex wave-train delivered at the tympanum. The facts here are difficult, and the descriptive account is not complete. It is found that one class of sounds may be identified as tonal, but that these sounds differ in various ways among themselves and are not simply loud and weak pitches to be strung on a colorless string or represented by a straight line. Among the rest of the sounds can be distinguished a class of noises, which have thus far resisted all attempts to order and to classify but which stand related in significant ways to some, at least, of the tones. Besides the tones and the noises one seems to discover intermediate sounds represented by certain constituents of the voice and of musical instruments. These intermediate sounds, sometimes called formants, are at once tonelike and noiselike. It appears that the aural functions cannot be properly understood until more is known about them. Helmholtz dismissed them as harmonic combinations of tones, but Hermann and others have shown that they are not so readily to be disposed of (as, for example, in the vowel sounds).

Coming back to the tones, it appears that these sounds—no matter how simply they are taken—are not to be exhausted by the epithets "high" and "low," "weak" and "strong." Among the other characteristics of them stand volume and brightness and perhaps vocality, tonality and tonal color.

Volume suggests a quasi-spatial attribute. It is the outstanding difference between the sonorous bass of a large organ-pipe and the small, sharp tinkle of a König cylinder of 15,000 vibrations. The one is not only grave and the other high, but the one is huge, massive and voluminous; the other small, fine and compact. Ever since Stumpf failed to reduce these differences to mere associative properties of the sounding source (e.g., the large pipe, the tiny insect), psychologists have generally acknowledged volume as inherent in tones and as an important clue to the functions of the ear.

Brightness, again, inheres in tones, increasing from below upward as the vibrational frequency is increased. High tones are also bright, and low tones dull. The first lucid description of this characteristic seems to belong to the physicist Mach, who possessed the knack—rare among physicists—of distinguishing what he heard and saw from the conceptual description of radiant and molecular energies, i.e., of distinguishing the experience itself from the stimulating agent acting on the receptor. It is easier to identify the brightness aspect of tones than it is to relate it exactly to the other attributes. A convenient way to observe brightness is by means of the siren disk with concentric rings. An air jet passed through the radial holes in these rings as the disk revolves acquires the same frequency of pulse and, therefore, gives a common pitch, no matter

where the ring stands on the disk. The sounds, however, differ notably in brightness and in dulness. This difference is probably independent of volume and loudness. Since these differences in brightness have been supposed to depend on the time ratio of disk aperture to intervening surface (and, therefore, to the form of wave-train), I was surprised to discover that they remain when the disk is replaced by simple radial sectors which presumably do not disturb the wave-train as the jet moves from the center to the periphery of the rotating mass. The relation of brightness to pitch and volume has been investigated by a determination of its difference limen (or rate of change) with change of frequency. One observer found that the difference limen for brightness roughly coincides with that for pitch and so concluded that they are different names for one and the same attributes. These observations, however, need checking. The difference limen for volume has been observed to be much larger than that for pitch, but nothing like a complete survey for either volume or brightness has yet been made for the entire tonal series. The term tonality suggests the musical relations of the tone to its octave. These tones are alleged to be more alike in a certain respect than either is like its immediate neighbors above and below. Vocality refers to the resemblance of tones to the vowel sounds. Good observers have found the vowels recurring in a regular order as tones pass from low to high. Other good observers have thought that the vocal character is not inherent in the simple tone. The plain fact is that the tone, although simple, presents so many qualitative shadings and so many sides and aspects that its adequate description is extremely difficult. Another decade may be required to clear up this descriptive account. Meanwhile, a regard for the facts does not permit a return to the old Helmholtzian simplicity and the older rigid parallelism of pitch with rates of frequency and of loudness with amplitude.

This matter of tonal character may seem to otologists to be merely an academic refinement without any real issue or importance, but that is not so. Until one knows the character of the simpler sounds, one can relate the sound itself neither to the physical properties of the stimulus nor to the structures and functions of the ear. A great deal hangs on the establishment of these triangular relationships. Without them one cannot interpret the comparative morphology of the fishes, amphibia, reptiles and birds, forms in which the sense of hearing was being elaborated. Neither can the anatomy and the physiology of the ear be understood, nor can one diagnose and treat all disorders of the hearing mechanism.

Before I go on to consider these relations for their own sake (the problem of auditory theory) I shall touch on the other acoustic qualities, the noises and the formants.

The problem of noise has presented a more serious aspect to the psychologist than to the physicist, who is inclined to group together all nonperiodic (i.e., nontonal) sounds as noise, vacillating between a vague physical definition and such psychologic epithets as "unpleasant," "rough" and "jarring." With but little aid, therefore, from the physicist in defining and controlling the stimuli for noise qualities, the psychologist has been backward in describing these sounds. Of late, however, he has been aided by the acoustic engineer who is constrained to take account of noise in order that he may eliminate it from his telephonic means of transmission. To be sure, noise is for him little more than the accessory and disturbing sounds which interfere with the distant delivery of speech and music, and he is, therefore, likely to overlook the fact that speech and music themselves include noises (taken in the psychologic sense) and would be distinctly impoverished by their elimination. It is worth something, however, to have even the grosser noisy sounds, as produced by controlled buzzer mechanisms, displayed in graph and oscilloscope and estimated by way of their masking effect on speech and on tone. It seems likely, therefore, that the engineer will considerably aid the psychologist's attempt to describe the noises. At present a tentative and temporary arrangement distinguishes two coordinate classes of explosives and continuatives and sets into a gross classification the thuds, cracks and pops among the explosives and the rumbles, roars and hisses among the continuatives. It is known that noises possess pitch (which is not, however, to be identified with tonal pitch) and that they differ with respect to both brightness and volume, which may or may not prove to be identical with the same properties of tone. In pitch, noises probably run neither so low nor so high as tones but approach the tonal qualities most closely at their lower and upper ranges; i.e., the lower tones are closer akin to the thuds and the rumbles and the higher tones (as in the Galton whistle and the König bars) to the hisses and pops than are the middle tones of the musical range to the intermediate cracks, crashes, bangs, snaps and roars. Music, therefore, easily makes use of the deep noisy drums and the shrill noisy whistles in its extreme registers, while it carefully guards its middle range from noisy contamination.

The physical analysis of vocal sounds reveals many noises among the consonants and relatively fixed components among its vowels. The psychologic analysis reveals noise qualities of a wide variety among the consonants and the peculiar formant standing in the vowel among tonal components which are chiefly harmonic to the fundamental. The formant moves within a narrow range as the tonal constituents rise and fall in the pitch scale, so that it is nearly the same in the bass, contralto and soprano voices. In pitch the formant is not to be identified with any tone but is clothy and fringy, although it is more tonelike than the noises.

My observation of the intermediate tone (Zwischenton) produced when an actuated tuning fork is rotated about its long axis leads me to suspect that there is here a physical means of producing either the formant or a missing link between it and the tone.

RELATION OF THE SIMPLER AUDITORY EXPERIENCES TO THE FORMS OF ENERGY DELIVERED TO THE COCHLEA AND TO AURAL STRUCTURES AND MECHANISMS

I shall now consider the second and third problems which bear on the relation of the auditory qualities to physical stimulus and to aural structure and function. The main contention here is that no satisfactory account of the acoustic functions is to be looked for so long as the character of hearing itself is not carefully derived. Every noise and formant, as well as every tone, interrogates the physicist and the physiologist; so does every aspect and attribute of each of the simple sounds. What corresponds in the wave-trains to the tone, noise and formant? What corresponds to pitch, volume, brightness, loudness and the rest?

These are initial questions, and with them must go parallel inquiries into the functions of tympanum and ossicles, oval window and helicotrema, endolymph, basilar membrane and tectoria, hair cells and nerve fibers, conducting pathways, basal nuclei and cortical fields.

This is where complication begins. All who are familiar with the literature of the last thirty years will—as I think—share my oppression at the tangle of theory and hypothesis. There are "place" theories and "frequency" theories, theories which bear the names of Helmholtz, Hensen, Ewald, Rutherford, Shambaugh, Meyer, Wrightson and several others. One finds varying and conflicting views about the function of the ossicles, the character of energy changes throughout the length of the scala vestibuli, the give and elasticity of the basilar membrane, the freedom of the fibers, the degree of local resonance and its causes, the exact mode of excitation of the hair cells, the processes of neural excitation, the functional specificity of the neurons, the refractory period or periods in the eighth nerve, the limit of neural impulses as related to the frequency of the stimulus, the distribution of the stimulus to the nerve fibers, the neural correlate of pitch, of loudness, of volume and of brightness, neural distinctions for tone, noise and formant, changes along the conduction pathways, the chemical processes in the cortex, the synergies of the right and left hemispheres, and so on.

THE VARIOUS MORE COMPLEX AUDITORY PHENOMENA

Suppose that all these tangles were cleared away and that all the facts had been pooled and made concordant as they derive from phyletic and individual history, from morphology, physiology and fine structure, from medicine, psychology and engineering. Not even then should one be

sure of an adequate doctrine of hearing. All the special facts and problems of the fourth division are still left. One can give them only a glance. The first is the curious fact that certain tones when they stand together in experience may be accompanied by additional tones—combination tones—for which no obvious stimulus exists. They are of two classes, the difference tones which are identical in pitch (at least) with those tones which could be independently produced by a frequency which is the difference of the frequencies of the primaries or some multiple of these frequencies. Thus the rates 2,000 and 3,000 double vibrations will give rise, under certain conditions, not only to the two corresponding tones but also to a tone pitched as of 1,000 vibrations (3,000—2,000=1,000) and (2×2,000—3,000=1,000). In a similar way two simple generators may give rise not only to the two corresponding tones but to a third which will represent the sum of their frequencies (2,000+3,000=5,000). It is called a summation tone. The difference tones are frequent enough and strong enough to produce musical effects. I have already spoken of the intermediate tone, which lies about midway in quality between two components. It leads to the phenomenon of beats. Here the psychologic facts are more complicated than the physical facts. Near-lying frequencies give rise on occasion to (1) a simple alternation of the loudness of a simple tone (e.g., 100 and 101 double vibrations with one loud-weak alternation in the second), (2) a regular alternation of tone and silence, (3) two rough "beating" tones or (4) a third, noisy tone. It has also been alleged that beats arise when the two frequencies are delivered separately to the two ears (binaural beats). All these facts are significant for theory and must be taken into account. The main fact in fusion is that when two tones exist together in experience it is not the same as when the same tones exist in temporal sequence, i.e., the two "fuse" to a distinct unity. These unities are expressed in "interval" terms, thirds, sixths, sevenths, octave, fifth, etc. Whenever one of these "fused" intervals occurs up and down the scale, it always bears the mark of "thirdness," fifthness," and so on. These unities also possess degree; the octave is closest, the fifth next, the fourth next, etc. These facts are extremely important in musical construction and appreciation, but they are just as important in auditory theory. Related to the fusions stand the consonances and dissonances, i. e., the character of suitability or defect in the various tonal combinations. One particularly striking fact about the internal relations of tones is the likeness already alluded to of any two tones which stand to each other in the octave relation. A tone is similar to its immediate neighbors; it is also similar, in a different way, to its octave, double octave and so on. This similarity has been variously conceived and accounted for by psychologists. Whatever it means it presents an obvious interrogation to the general problem of aural function.

One of the most extraordinary accomplishments of the aural functions is the nice account which they take of spatial direction or localization. Especially in the horizontal plane passing through the head are sounding objects accurately placed. This function is generally binaural, and thus it affords a rare chance for studying the conjoint operation of the two ears. Earlier, when theory was simple, it was thought that auditory localization rested on the intensive ratio of stimulation at the two ears; it has since been found that the localization more ultimately rests (at least in large part) on small temporal differences to which the double ear is enormously sensitive. If a single source (as from a tuning fork or an audio-oscillator) is led separately by unlike distances to the two ears and the two wave-trains are brought into unlike phase, it may be observed that a gradual change in phase will lead to the perception of a traveling source. Like phase places the sound in the sagittal plane before, behind or within the head, while a leading phase on the right or the left swings the sound to the same side. There seems to be evidence here of a central synergy (perhaps by way of cortical or subcortical spread or inhibition) which coordinates the separate functions of the two disparate ears. Whether the synergy is of the same order as the optical tract, which gives one binocular vision and facilitates the perceptions of distance and depth, has not been made out. It seems likely that monaural localization is really tactual (at least in part), depending on pressure organs in the tympanic membrane. Indeed, the close anatomic alliance of audition with this extremely sensitive part of the body surface suggests to me that the tactual component in what is regarded as purely auditory may (as in the case of smell and taste) include a borrowed dermal component of considerable importance. To discover it a careful qualitative comparison should be made of sounds aerially mediated through the tympanum and sounds directly conducted (if that is possible) through the bones of the head to the endolymph. Patients lacking in one tympanic membrane and the malleus and incus might also be trained to compare diotic sounds. Another important use to be made of phase difference is a direct comparison of two successive sounds diotically produced, as mentioned, with unlike amounts of phase difference. I disregard spatial localization and instruct the observer to report on the likeness or difference in the successive sounds with respect to pitch, loudness, volume or brightness. Research in my laboratory indicates that these sounds differ only in brightness. Although there are thousands of observations methodically acquired, more experiments are needed on this difficult matter. If phase difference does affect brightness but not pitch, volume or loudness, under these conditions, the fact may be important for the central theories. It is worth noting that a shift of phase would seem to distort the wave-train (and its neural repre-

sentatives) much as the siren disk does, and there, as one remembers, the outstanding aspect of the tone is just brightness.

The whole topic of audition is now one of the most thrilling and alluring of all the problems of science. Moreover, it seems to me to offer today better promise of substantial advancement than it has since the days when the genius of a Helmholtz first crystallized the known facts into a simple doctrine. One reason for my optimism is that one can count in America alone at least a dozen men who have researched competently in this field and who have a sufficiently broad and catholic view of the problem to advance its present status. Doubtless other names can be added from the medical side. As for my own tentative understanding of the intricate resources of the organism in perceiving music, speech and the sounds of nature and of industry, I must say that it stands in the stage of revisable but working hypotheses. Nearly every statement in a general doctrine of audition would be introduced by such phrases as "it looks as if," "the clearest evidence suggests," "it seems most plausible to believe that," and "this research supports the view." Let me suggest in a brief way my crude approach to such a doctrine.

The remarkable powers of analysis by the organism of the complex patterns of energy delivered through the external meatus call for a sifting and sorting mechanism. Sound waves come in the air in complicated and confused patterns, but one hears individual sounds and significant melodies and sentences. The only way to avoid the search for an aural mechanism of analysis is to shut the eyes and blindly declare that the "brain" or the "mind" or the "soul" is able to sort out the first violin or the accompanying voice in the unseen radio orchestra or to identify a companion's speech in the noisy street. Time and space are the two great agencies of analysis. One conveniently puts the parts of things or events "here" and "there" or "then" and "now," and thus distinguishes them. Time is of great importance in hearing; however, it has not been sufficient to the simultaneities, although even here it appears in evenly spaced cycles of energy of variable rate. Space is most easily introduced by such a place theory as Helmholtz', which rests on the respectable principle of sympathetic resonance. It is now obvious, in view of all the recent complications, that this theory can at most be salvaged but not saved. The acoustic engineers have lately proposed to salvage it by importing the electrical concepts of resistance, impedance, inductance and capacity. As Troland recently observed, the value of these concepts can scarcely be appraised by any one who is not an alternating-current engineer; it nevertheless appears that the engineer has not yet sufficiently assimilated all the relevant facts, especially psychologic and physiologic facts, to carry conviction to many competent investigators in the general field. He still harks back to the simplicities of an earlier day.

If actual physical conditions within the cochlea (i.e., in the endolymph, basilar membrane and superimposed structures) exemplify the physical principle that the area of maximal displacement in the cochlea is a function of vibrational frequency, one seems to have here a means for explaining the observed analysis of sounds by a combination of place and of frequency. This is not wholly unlike the old telephonic theory of Rutherford. It would do away with the tuned strings of Helmholtz and with specific energies of nerves, although Ebbinghaus long ago showed the latter doctrine to be unnecessary in hearing. The observed differences of dimension and of mass of the basilar membrane may still be conceived as allowing a variable resistance to the energy of the stimulus. The principle of shifting maximal response as frequency changes is attractive; although it will have to be applied with caution until the energy involved at the hair cells is shown to be consonant with the stimulus limen for these structures. The point at which the hair cells would be just excited would have to be nicely adjusted to the maximal displacement to account for the high discrimination observed in tones. Also the mass of endolymph, the distance and obstruction of the helicotrema and the coordinated functions of the oval and round windows would have to be exactly adjusted to the observed lower and upper limits of the tonal scale. Of course, the principle also rests on the all-or-none law of neural action, which is applicable to the cochlear branch of the eighth nerve only by hypothesis. Furthermore, the alleged dependence of pitch on frequency has to square itself with the refractory period, which should be much shorter than any yet observed if it is to account for the higher tones. Then, moreover, any theory of aural function will have to deal with the troublesome fact of refractory period. The difficulty is not insuperable in the present proposal, and it has the virtue of demanding much more accurate knowledge of the total number of tones (especially high tones). This is a challenge to the psychologist.

To account for the combination tones, Helmholtz had recourse to the asymmetrical tympanum and the consequent distortion of vibratory form in the endolymph. Analogies recently found in the vacuum tube have helped in the understanding of these additional tones. A recalculation of the foci of maximal displacement under distortion suggests, much as Ebbinghaus proposed about thirty years ago, that even sinusoidal waves excite not one focus but several foci on the basilar membrane.

One fundamental difficulty with any theory which seeks to account for the vast variety of sounds—tones, noises and formants—is that it has to provide for a wide range of loudnesses or intensities as well as for the observed qualitative variety. The anatomist no longer approves the Helmholtzian model of selectively vibrating radial fibers, the psychologist finds that loudness is not a simple function of amplitude, and the neurologist, having declared that the nerve fiber acts either not at

all or at its fullest capacity and is not, therefore, tempered to the energy delivered to it, objects to a graduated activity of the physical stimulus. It has been suggested, accordingly, that loudness should be correlated rather with the number of neuronal fibers excited, and all the sciences have been trying of late to work out the puzzle on this suggestion. There are difficulties to be encountered, however, even when one leaves out of account everything except pitch and loudness. Every tonal quality has its own range of loudness (as if it were independent of frequency); but high tones are intrinsically loud and low tones weak and again the loudness range (i.e., D L for intensity) widely differs at different frequencies (as if frequency were a determining matter). To get loudness and pitch, then from cooperating receptors and fibers with limited rates of excitation and ungraded discharges is one of the back-breaking tasks of any current auditory theory.

One suggestion is that frequency may determine the number of regularly spaced impulses in one or more fibers (using a group wherein one fiber discharges after another when the refractory phase is too brief for one single neuron to respond to every displacement at the higher frequencies). Loudness, therefore, would be accounted for by the total number of impulses released in unit time by all the fibers involved. This accords with the view of intensity as determined by the spread of excitation from fiber to fiber. It makes it difficult to understand why high tones are intrinsically loud (as compared with low), for the higher frequencies are supposed to produce sharper and more restricted maxima in the cochlea. They should, therefore, affect a smaller number of fibers and thus be correlated with weaker tones. On the other hand, the imperfect cooperation of several fibers under high frequency might explain why the discrimination for pitch is gross among very high tones; but it would scarcely reveal why it is also gross among very low tones.

It is obvious that when one tries to deal with no more than two psychologic variables (pitch and loudness) by way of the new neural physiology of total discharge, impulses, trains, refractory period and recovery and with the aid of the physicist and the engineer, the psychologic facts are too complicated, the anatomy too uncertain and the neural functions still too little known to give one a dependable and definite theory. And when one adds to pitch and loudness the attributes of volume and brightness, the facts of octave resemblance and fusion degree, the shift of localization with difference of phase, and the significant facts of beating complexes, the task is still greater. Here the acoustic engineer does not greatly help. Knowing a good deal more about the physical traditions than he does about psychologic description and psychophysical method, he naturally feels safer when in sight of Helmholtz and Raleigh than in listening to Stumpf, Ebbinghaus and the

American contemporaries who are wrestling with the task of describing sounds as they actually sound. But if the new facts break one's head, they also check one's inferences and they suggest new terms of explanation. The facts that low tones are massive and voluminous, high tones compact and tiny, low tones dull and high tones bright have just as much to be taken into account as differences of pitch and loudness. Psychologists have approached the problem by observing the differential rates of change of pitch, volume and brightness throughout the tonal scale. The results are impressive but still inadequate and incomplete. Workers in my laboratory have investigated from the side of phase differences, taking advantage of the enormously significant fact that the ear (or the brain) is susceptible to temporal sequences of a minute order, as revealed by the shift of localization with slight advancements of the right or the left phase in the diotic hearing of a single frequency. We have sought to discover how the total tone quality changes with these slight shifts of phase. Although this research is incomplete, it looks as though central distortion under phase difference was represented by changes in brightness and not by any modification of pitch, volume or loudness, much as the modification of wave form in Abraham's disk siren leads to striking changes of tonal brightness. To get at the interactive relations of volume and intensity, we have tried to modify volume by large changes of amplitude; volume does not seem, however, to vary with loudness. When tones were approximately equated in loudness the volumic difference remained. No feasible shift in amplitude sufficed to bring together the volume moments of different frequencies, as Boring and others had thought. If volume is a function of frequency and independent of amplitude, Troland's suggestion that it rests on the number of cooperating fibers excited seems plausible. Since brightness is obviously involved in the vowel sounds, there is here a suggestion for bringing in the formants of speech to theorizing. Perhaps the hint that the physical correlate of the formant appears to be a distortion of sinusoidal displacement, much the same as the siren disk and the phase displacement give, may be worth recording. All the facts considered, volume and brightness suggest a differential means of determining cochlear and cerebral participation in auditory functions. Any adequate theory must, of course, deal with the central nervous system as courageously as with the ear. This reference to speech suggests the reflection that the nontonal simple sounds (including the noises), as well as fusion, beats, consonance and other experiential phenomena of higher order, will probably have to be gone into much more thoroughly than they have yet been before an adequate theory is derived. In connection with tones, I have emphasized the analytic functions of hearing; noise, fusion degree and beats remind one that nonanalysis and gross excitations are just as important aspects of hearing and must be given due weight in any respectable doctrine.

CONCLUSIONS

Everywhere, once more, complication. I believe, nevertheless, that the great increase in the number and variety of the facts to be brought within the single net of theory and understanding not only is fertilizing research, but will also ultimately lead to one single integration of the facts and so do away with the embarrassing number of old but superficial and inadequate theories, each advertised under its creator's name. In the meantime, one need not be impatient of the final outcome, so long as real problems which all insist on understanding are leading toward the laboratory and the clinic for genuine research.

The otologist will have been struck and possibly disturbed by my emphasis on the psychologic side of this common problem, but that emphasis was inevitable. As I contended at the beginning, the psychologist must have his focus and margin, his point of view and his distinctive problems. The focus of the otologist is defect and remedy, the engineer's range and efficiency, the physicist's mechanism, and the neurologist's excitation and mode of propagation. This is as it must be. The chief danger in this just division of labor, as I see it, is the temptation to departmental narrowness. As I cannot be an otologist or an acoustic engineer, so the otologist cannot be a psychologist or a physicist. Nevertheless, each one may be intelligent on the methods and the results of his fellow workers. Should any one ignore those facts of audition which are foreign to his particular field, he would fall short in his contributions to the common problem. It is the otologist's recognition of this sympathetic and catholic attitude which I do but echo and which is illustrated both by the cooperative spirit in the past and by the generous invitation of the president of this society that has suggested my topic and given me the opportunity to address this society.

Clinical Notes

DIPHTHERIA OF THE EAR*

DAVID NUSSBAUM, M.D., PHILADELPHIA

D. L., aged 2½ years, was seen by me on March 11, 1929, with a history of persistent cough almost since birth. The family physician was not able to make any impression on the condition. The tonsils and adenoids were removed when the child was 10 months old, but the coughing continued.

I had the good fortune to obtain decided relief for the patient within a short space of time.

On March 18, an older brother developed otitis media. A paracentesis was performed, ample and free drainage was established, and after the lapse of two weeks the ear was normal.

Probably from contact with his brother, the present patient developed a slight rise in temperature for a few days and complained now and then of pain in his right ear. His condition was such, however, that he did not require any treatment until March 20, when he was seized with sharp, stinging pain in his right ear and was brought to my office.

On examination, I found a slight mucoid discharge in both nasal chambers, and a congested, swollen and bulging drum on the right side; the left drum appeared to be normal. I incised the diseased drum and obtained a purulent discharge. After treating the patient for the nasal condition, I sent him home.

The child failed to do well after the paracentesis. He complained of persistent pain in his ear, and did not allow his face to be touched. He was restless, hardly slept that night and had a temperature of over 102.5 F. The discharge was scanty and thick. This behavior is not unusual, at least until free drainage appears. I felt calm, therefore, and had the parents share my optimism.

After thirty-six hours I saw the patient again and was far from pleased with his condition. He still had a temperature of 102.5 F., was extremely restless and complained continuously; his entire general appearance was that of a very sick child. The right mastoid process was extremely tender. The patient would cry out from pain at the slightest touch, and he carefully avoided lying on the diseased side. The external canal was filled with a thick purulent discharge, which was not sufficient, however, to run out on the pillow.

I could not but think of those fulminant cases so common in some epidemics of grip, which require immediate operation at the beginning of the illness, and in which delay means disaster.

After wiping the canal clean, I observed a condition that I had never seen before. The entire drum was covered with a thick, white, firmly adherent membrane. It appeared as one solid homogeneous mass sharply demarcated from the walls of the apparently normal external canal, as if a white artificial drum had been inserted. Through this mass ran the slitlike incision that I had made; it looked dry, and little pus was seeping through.

For a moment it seemed to me that I was dealing with a foreign body, and I was agitated by the possibility of having misjudged the situation and having done the wrong thing.

* Submitted for publication, May 23, 1929.

* Read before the Mount Sinai Clinical Association, April 22, 1929.

The patient was too exhausted for any further manipulation in the ear, and I decided to wait until the next day. In the middle of the same night, however, the mother called me up, reporting that the patient's condition was desperate; he had not slept and he had been in continuous pain for forty-eight hours.

I saw my patient on the following morning and removed from the drum a large piece of whitish substance, about 2 mm. in thickness; the underlying surface was raw, deep red, ulcerated and bleeding. The local and general symptoms remained the same.

I now thought of diphtheria, but while I knew of a diphtheritic exudate on mucous membrane surfaces I had never heard of one on skin; as is known, the outer covering of the drum, facing the external canal, is cutaneous.

Following this, the patient had a few hours of sleep. The discharge became more copious, but the temperature would not fall from 103 F.; earache and tenderness of the mastoid process persisted with the same intensity.

Seventy-two hours after the paracentesis, I noticed a slight redness and excoriation around the right nasal vestibule which yielded a scanty mucopurulent discharge; this was also noted by the mother. On closer examination I discovered, occluding the right nasal chamber, a thick white exudate of the same appearance and consistency as that covering the drum of the same side.

Even then I thought the condition might be a streptococcic infection, which could give an identical pathologic picture. I took no more chances, however, and injected 10,000 units of diphtheria antitoxin; at the same time, I took a culture from the nose, from the pus of the canal and from the scrapings of the drum, which had re-formed. All three cultures were positive for diphtheria, and the tentative diagnosis was thereby confirmed.

From then on, after the first twelve hours, improvement became noticeable and progressed steadily. The discharge became profuse and tinged with blood; the pain and tenderness over the mastoid subsided gradually, and the patient was able to lie on the diseased side, which he carefully avoided doing before. The fever went down in a lytic curve and disappeared entirely three days after the injection of serum, as did the exudate covering the drum and nasal mucosa. The tympanic membrane, however, was slow in recovering; a macerated and bleeding condition persisted for almost two weeks.

Four weeks after the onset of the symptoms, the child was completely normal; there was a scanty discharge from the ear, and the drum was returning to a normal condition.

Diphtheria of the middle ear is a rare occurrence. The literature on this subject contains only a few cases. In 1923, Scalas reported three cases in children, two following nasopharyngeal diphtheria and the third after a tonsillectomy. Pugnat gave a detailed description of this type of case and mentioned pain, bulging of the drum that was due not to pressure of secretion in the tympanic cavity but to the presence of pseudomembranes, a serosanguineous discharge and a macerated drum as pathognomonic symptoms.

The etiologic factors are Loeffler's bacilli in pure culture, but mixed infections with diplococci and streptococci are frequently present. Like scarlet fever infection of the middle ear, diphtheria leads to chronicity of the pathologic process and to complicating mastoiditis. When mixed infection is superimposed, the streptococci predominating, there is great danger of septicemia or endocranial involvement. In a few instances diphtheria bacilli may be found in the purulent discharge even after the lapse of several years, stamping the patients as dangerous carriers.

The treatment is similar to that for diphtheria in other parts of the body, namely injection of serum; it proves of great value in pure, uncontaminated cases. Instillations of antitoxin in the auditory canal and typmpanic cavity are effective when mixed infection supervenes.

In one case of Scala's, in spite of sufficient injection of serum, the suppuration persisted, became chronic and eventually led to permanent destruction of the drum.

On the other hand, even severe and complicated cases may end in spontaneous healing without surgical interference; a case in point is that reported by A. Kahn (New York).

A man, aged 20, was sent to the hospital with the diagnosis of mastoiditis, and with the demand that he should be operated on at once.

The patient did not complain of sore throat, nor were any symptoms of this sort present. He was extremely weak and toxic, had severe headaches, a profuse purulent discharge from the external canal, excruciating pain over the left mastoid and agonizing earache on the left side.

Routine examination revealed a patch the size of a five cent piece in the nasopharynx, surrounding and including the eustachian tube of the involved side; it was firmly adherent and bled easily on attempts to remove it. The drum was macerated, and a membrane involved the mucous lining of the middle ear; on attempts at removal, it bled freely.

The patient was so toxic that the surgeon feared that the operation would open a large raw area, which might be a new source of toxicity. Instead, 10,000 units of antitoxin was given with miraculous results in less than twenty-four hours. The patient's general condition showed vast improvement, the pain and tenderness over the mastoid diminished, and the previously profuse discharge from the ear became scanty.

Improvement continued, and this patient, like mine, was discharged as cured without an operation.

CONCLUSION

Two brothers living under the same conditions, in the same house and subject to the same exposure, developed acute otitis media two days apart.

The same treatment was given to both, yet while the older brother made an uneventful recovery, the younger one developed the rare complication of diphtheria of the drum; this diagnosis was corroborated by bacteriologic data and subsequent events.

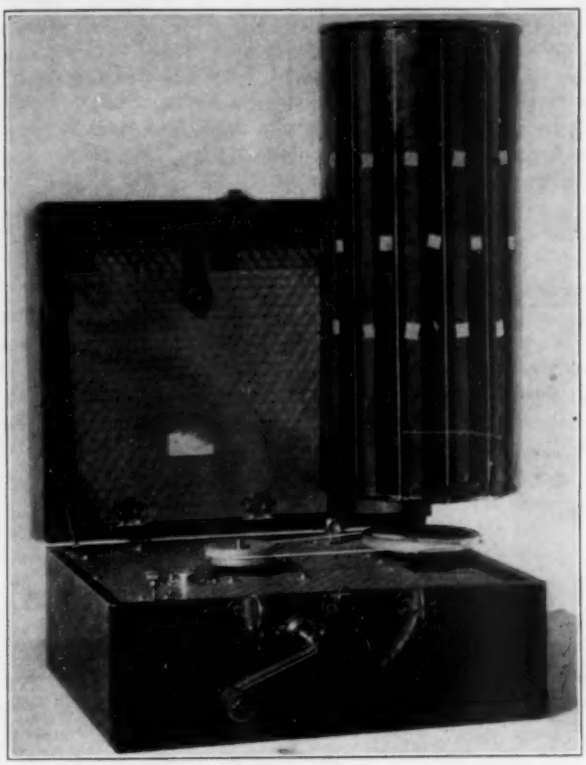
The pathway by which the infection traveled is unknown. I am certain about the negative nasal condition because I examined and gave treatment for it before performing the paracentesis. There was no pathologic condition of the throat and no indications for a postrhinoscopic examination, which is difficult in small, nervous and fretful children. Most careful inspection did not reveal a membrane in the tympanic cavity at any time; neither was the drum badly macerated, although it looked raw and bled freely on manipulation or on syringing of the external canal. Granted that there was a patch in the postnasal space that I overlooked and that the tubal route was the pathway for the infection, why were there no membranes in the middle ear?

It seems to me that the foregoing is one of those rare cases in which diphtheria affects the cutaneous portion of the drum. I lay special emphasis on the word "cutaneous." I may also add that the trauma caused by the paracentesis was minimal.

OPTIC NYSTAGMUS TEST*

E. R. Carpenter, M.D., Dallas, Texas

Holmes, Bárány, Stenvers and others have contributed articles on the value of the optic nystagmus test in the localization of lesions in the cerebral hemispheres. Various devices have been used to elicit this form of nystagmus. The simplest means is a drum revolved by hand, but this is not easily accomplished with the accuracy that should accompany scientific tests of this nature.



Instrument for testing optic nystagmus.
(reversible)

Appreciating the importance of this adjunct to diagnosis and localization and the difficulty of procuring a suitable apparatus for the test at a reasonable cost, I devised the drum and motor shown in the accompanying illustration. The tin drum is mounted on a small motor used in a phonograph, and the total cost of the instrument should not exceed $35. Since the test is not in general use, although it should be, and since it is of special interest to all oculists, aurists and neurologists, possibly a brief description of the apparatus and its employment should be included.

* Submitted for publication, April 26, 1929.

The drum should be about 7 inches (17.7 cm.) in diameter and from 12 to 15 inches (30.4 to 38.1 cm.) in height. It should have vertical columns of about 2 inches (5 cm.) in width laid out on its surface, and in the columns bright objects the size of 20/40 test type should be painted or pasted in even formation about 3 inches (7.6 cm.) apart. The speed of the drum should be adjusted to 40 turns per minute. With the drum located as seen in the illustration, a reverse direction is obtained by crossing the rubber band which connects the drum and motor shaft. The drum should be detachable in order to be portable. The patient should be seated at 20 inches (50.8 cm.) from the drum facing a good, soft light, and should gaze directly at the bright objects as they pass in front while the drum is being turned.

The nystagmus consists of a slow movement of the eyes in the direction of rotation of the drum and a quick movement in the opposite direction. The oscillations vary somewhat in different persons, but the movement should be similar and equal to the right or to the left as the drum is rotated in the clockwise or anticlockwise direction, and the movement should be well sustained while the drum is revolving. The test is easily made and is reliable even when only a small amount of vision remains. It is not affected by hemianopia due to lesions of the optic radiations or of the chiasm.

As a result of a study of twenty-five patients in whom the optic nystagmus test revealed abnormalities and in whom the lesions were verified by autopsy or operation, Gordon Holmes stated:[1] "It seems, however, that nystagmus to the opposite side is affected when a lesion lies in the supramarginal or temporal gyrus, in the adjacent portion of the parietal and temporal lobes, in the posterior end of the second frontal convolution or along the line joining this with the angular gyrus. Our observations consequently tend to support Stenvers' hypothesis that reflex centers for optic nystagmus lie in the occipital lobe and in the second frontal convolution, and that these are connected by a reflex path which runs through the white matter of the hemisphere."

A NEW TONSIL SUTURE FORCEPS*

ROBERT WATT, M.D., PHILADELPHIA

In presenting this instrument to the profession, I fully realize that there are a number of tonsil suture forceps on the market that have been devised for the purpose of controlling bleeding in the tonsillar fossa. But I have found all to have one or more serious objections, the chief of which is the slotted or open eye of the needle, which catches the tissue when the needle is being withdrawn, causing a tearing and laceration, and sometimes tearing the vessel, thereby causing more bleeding than it was at first attempted to control.

For some time, it has been my desire to devise an instrument with a closed or round eye needle which could not catch in the tissue or create any traumatism. With the cooperation of the George P. Pilling & Sons Company, an instrument has been devised which, I believe, will fill a long felt need.

The instrument is a forceps-like arrangement with a closed eye needle on the one side and a receiving unit for the needle on the other side. The eye of the

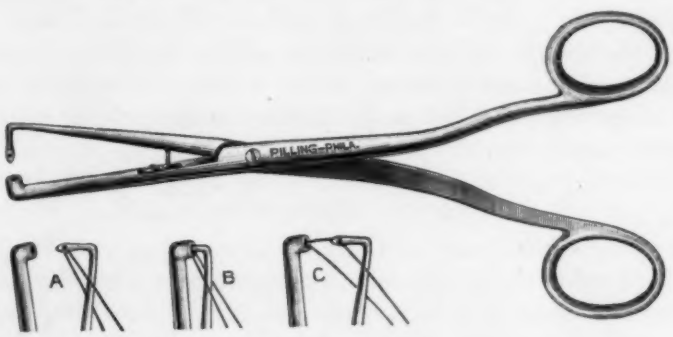
* Submitted for publication, June 4, 1929.

1. Holmes, G.: Brain **49**:371, 1926.

needle is capable of taking a number 00 or 0 size catgut. I have found the number 00 size large enough for tonsillar work. The tonsil end of the instrument is small and neat and can easily be introduced into any portion of the tonsillar fossa without difficulty.

In the upper part of the accompanying illustration is shown the instrument in full, unthreaded. *A* shows the needle threaded, *B*, the instrument closed and *C*, the instrument opened, showing the thread engaged on the opposite side from the needle. When the instrument is in use, only one end of the catgut should be fastened to the clip near the finger ring, the other end being left free to slide through the receiving end of the instrument on withdrawal after it is placed in the tissue or under the vessel to be ligated. I think it better to leave both ends free.

The technic is as follows: The bleeding point is grasped with a hemostat. The needle of the instrument is threaded with 00 or 0 catgut previously softened by soaking in sterile water. With the hemostat, slight traction is made on the tissue to raise it slightly; the suture forceps is introduced slightly open to the base of the pedicle, so that the needle when closed passes beneath or under the bleeding



Tonsil suture forceps.

vessel. The instrument is then closed tightly, immediately reopened and withdrawn; it will be found that a small device on the receiving side has caught and held the catgut, so that when withdrawn and released from the instrument, the catgut passes through the tissue under the bleeding vessel. The catgut can now be tied like any other ligature, or, if preferred, a knot tier can be used to tighten the knot. I prefer the fingers, as I then feel more sure that the knot is tight enough.

The chief advantage of this instrument is the round closed eye of the needle, with no openings or slot to catch and tear the tissue. The simplicity of using it, the small size of the needle and the neat tonsil end of the instrument make it capable of being applied to any portion of the tonsillar fossa. The instrument could also be made with a larger and longer needle for abdominal and pelvic work.

Feeling sure that this instrument will be an asset to the armamentarium of the otolaryngologist, giving him more confidence and less foreboding of trouble from hemorrhage in his work, I present it for what it is worth until some better method is discovered.

3142 Frankford Avenue.

Progress in Otolaryngology

A Summary of the Bibliographic Material Available in the Field of Otolaryngology

ACUTE AND CHRONIC OTITIS MEDIA AND SINUS THROMBOSIS *

SAMUEL J. KOPETZKY, M.D.
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The literature dealing with my topic is less rich than usual this year. While many interesting cases are reported, few of them contribute any new data. Many of the recorders concern themselves with a restatement of therapeutic measures which are already well known; and while this makes a valuable record of divers experiences with the curative agents at our command, it does not furnish suitable material for a survey concerning itself with the progress made in otology.

ACUTE OTITIS MEDIA

Heretofore, it has been held that the course of an acute infection of the middle ear is determined to a great extent by the anatomic development of the temporal bone and the nature of the invading organism. While the character and virulence of the hostile organism and the nature of the terrain attacked must inevitably influence the outcome of a case, Wirth [1] has questioned the prognostic value of these two factors. Rudakow [2] reported that he has a fairly accurate prognostic guide in a test which has been used in gynecology to estimate the body's resistance to a given bacterial invasion. This test was reported on by Bumm, Sigward, Ruge [3] and Philipp [4] and is known as the Ruge-Philipp test. Rudakow applied it in the following way to the study of the bodily resistance in acute infections of the middle ear:

* Submitted for publication, Aug. 13, 1929.

1. Wirth: Die Abhängigkeit des Verlauf der akuten Mittelohrenzündung von bakteriologischen und anatomischen Einflussen, Ztschr. f. Hals-, Nasen- u. Ohrenh. **18**:350, 1928.

2. Rudakow, W. O.: Zur bakteriologischen Diagnostik und Prognostik der Ohrenkrankungen, Arch. f. Ohrenh. Nasenh. u. Kelkopfh. **119**:116, 1928.

3. Ruge, C., Jr.: Studien zur Virulenzprüfung der Streptokokken, Arch. f. Gynäk. **121**:363, 1924.

4. Philipp, E.: Virulenzbestimmung von Blutkeimen, München. med. Wchnschr. **70**:493, 1923.

From the cubital vein under strictly aseptic conditions, from 3 to 4 cc. of blood was obtained. This was defibrinated by being shaken in a sterile tube containing pearls for from five to ten minutes. To the defibrinated blood was added one or two drops of pus taken aseptically from the middle ear. One-tenth (0.1) cc. of this mixture was then mixed with 5 cc. of melted alkaline agar cooled to 50 C., and this was then poured into a Petri dish. This preparation and the remainder of the pus and blood mixture were placed in an incubator. After three hours, a second preparation with agar was made and plated on a second Petri dish, which was placed in the incubator. Both plates were examined after twenty-four and after forty-eight hours, depending on the rapidity of growth; and the colonies on the first and those on the second plate were counted. When the defensive endeavor of the body was stronger than the invading power of the bacteria, the second plate showed a smaller number of colonies than the first. When the reverse was true, the second plate gave the larger number of colonies.

Another prognostic method was reported by Hesse,[5] who stressed the importance of the supravital staining of smears from the acutely purulent middle ear. Hesse held that the finding of the type of the organism or the demonstration of pus microscopically is not nearly so important as the determination of whether the leukocytes in the pus are viable or dead. A preponderance of unstained or poorly stained leukocytes denotes a virulent infection and is an indication for antrotomy, whereas a smear showing a majority of stained leukocytes indicates that the body is capable of coping with the infection without surgical intervention.

Further data on prognosis and diagnosis were furnished by Vermes and Brügel.[6] These investigators made a study of the calcium content of the blood in all types of disease of the middle ear. They found calcium increased or at the upper norm in acute otitis media purulenta, whether accompanied by an acute mastoiditis requiring surgical intervention or not, in middle ear catarrh and in chronic mastoiditis. They considered that their observations substantiate the histologic assumption that osteoclasis and osteogenesis occur simultaneously in all acute lesions of the middle ear. They interpreted an increase in the blood calcium as indicating only that an increased resorption of calcium salts was taking place somewhere in the body. According to them, an increased calcium content in the blood cannot be used as an indication for operative intervention.

Useful as all these aids to diagnosis and prognosis are from the standpoint of clinical research, they cannot be substituted for clinical judgment in actual practice.

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5. Hesse: Supravitalfärbung von Sekretleucocyten bei akuten Mittelohreiterungen, Ztschr. f. Hals-, Nasen- u. Ohrenh. **18**:377, 1928.

6. Vermes, E., and Brügel, S.: Ueber den Kalziumgehalt des Blutserums bei Mittelohrentzündugen, Monatschr. f. Ohrenh. **62**:33 and 203, 1928.

Wittmaack postulated that the occurrence of a purulent otitis media in infancy influences the orderly, normal pneumatization of the mastoid process. Knick and Witte,[7] who made roentgenologic studies in patients of this kind under 1 year of age, reported that only in a small number did they find any disturbance of pneumatization or cellular structure. They are in direct opposition to the contention of Wittmaack that disturbed pneumatization is present in every case of infantile otitis.

There is an increasing number of reports of various types of tumors in the middle ear. Richman [8] reported a vascular tumor of the membrana tympani which appeared as reddish-brown elevations of the posterosuperior quadrant of the drum, the remainder of the drum being normal. On incision of this mass, profuse bleeding occurred. The patient was subjected to radium therapy, with the result that the originally vascular mass shrank and assumed a gray color. Richman attributed this tumor to an abnormal development of the blood vessels in the drum as a result of otitis media in infancy.

MacKenzie [9] reported an unusual type of growth in the middle ear. Otoscopic examination revealed at the depth of the canal a small red swelling which was firm to the touch and which bled spontaneously on several occasions. At operation, the mastoid structure showed a peculiar greenish-yellow discoloration of the membrane lining the cells, which gave every indication of being due to hemosiderosis. On exposure of the middle ear, the tumor mass was found to arise from the blue, smooth surface of the bulb of the jugular vein, which protruded into the middle ear. When the tumor was snared off, profuse bleeding from the bulb followed. Histologic examination showed it to be a connective tissue tumor with no mitotic figures.

Incidentally, in connection with the aforementioned report, Slobodnick [10] stated that in children aged up to 10 years and in people who have had rickets, protrusion of the bulb of the jugular vein into the tympanic cavity is of relatively frequent occurrence. He cited a case in which the pulsations of the bulb were visible through the intact membrana tympani.

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7. Knick, A., and Witte, W.: Röntgenologische Studien über die Entwicklung der Wartzenfortsatzzellen nach Otitis media im ersten Lebensjahre, Arch. f. Ohrenh. Nasenh. u. Kelkopfh. **119**:128, 1928.

8. Richman, F.: Report of a Case of Vascular Tumor of the Membrana Tympani, Laryngoscope **38**:94, 1928.

9. MacKenzie, G. W.: Fibroma Arising from Jugular Bulb and Invading the Middle Ear and External Auditory Canal, Laryngoscope **38**:232, 1928.

10. Slobodnick, M.: Pulsation und Durchscheinen des Bulbus venae jugularis durch das intakte Trommelfell mit Beschreibung einiger selbst beobachterer Fälle, Ztschr. f. Hals-, Nasen- u. Ohrenh. **19**:240, 1927.

All types of micro-organisms continue to be reported as causative factors in acute purulence of the middle ear. Occasionally, some of the organisms met with are so rare as to deserve special comment. Franz [11] reported two cases in which the paratyphoid bacillus was isolated from the pus in the middle ear. In these cases, mastoiditis and sinus thrombosis developed. Wirth [12] reported two cases in which the organism isolated was one hitherto undescribed. In both these cases, cultures following myringotomy showed no pathogenic bacteria. On the fifteenth day of illness, in both cases, mastoiditis developed, then sinus thrombosis and septic icterus. Autopsy showed enlarged spleens, multiple abscesses of the lungs, purulent meningitis, arthritis and pleurisy. Microscopic examination of the pus from all the regions involved showed a gram-negative bacillus. Cultural, it proved to be a selective anaerobe, polymorphous and motile. It was pathogenic for the mouse, rabbit and guinea-pig. Wirth thought that it was probably identical with *Bacillus fundibuliformis.*

Hesse [13] discussed the acute otitis found in the course of influenza. The clinical picture is that of a hemorrhagic drum and external canal. It either clears up quickly or goes on to suppuration. Of the 100 cases of influenza dealt with in his report, 80 showed an acute purulent otitis media. In none of these was the influenza bacillus isolated. Seventy per cent of the 80 cases showed anhemolytic diplococci and streptococci; 10 per cent showed a hemolytic streptococcus; 7 per cent the pneumococcus (type III), and 3 per cent the pneumococcus. He attempted to produce an acute purulent otitis media in a rabbit by instillation of a pure culture of the influenza bacillus into the ear. The rabbit inoculated was killed after six days. The ear was found dry. A second rabbit was inoculated, a pure culture of *Bacillus influenzae* being instilled into one ear and a mixture of influenza bacilli and hemolytic streptococci placed in the other middle ear. The ear infected with the mixture of organisms subsequently presented a purulent otitis, whereas the other ear presented no pathologic change whatsoever. Hesse felt that *B. influenzae* alone cannot produce otitis media; but that when it is combined with a streptococcus, both together produce a purulent infection. In passing, it is to be noted that in the cases of influenzal otitis in which an operation on the mastoid process was necessary no breaking down of the cells was noted, an observation to which further reference will be made.

11. Franz, H.: Ueber zwei Fälle von Paratyphus im Mittelohr, Ztschr. f. Laryngol., Rhinol. **16**:307, 1928.

12. Wirth, E.: Seltene gramnegative anaërobe Bazillen als ungewöhnlich bösartige Erreger von akuten Mittelohrentzundungen, Centralbl. f. Bakteriol. **105**:201, 1927-1928.

13. Hesse, W.: Otitis bei Influenza, Ztschr. f. Laryngol., Rhinol. **16**:479, 1928.

Beyer [14] discussed the otitic infections seen during the epidemic of grip of 1927 in Berlin. He found hemorrhagic exudates into the mucosal layer of the drum and perforations in Shrapnell's membrane. Rarely was there any free pus in the mastoid process. The cellular membrane was swollen and hemorrhagic. Destruction of cell walls was noted rarely.

The observations of Keogh [15] are in accord with those of Hesse and Beyer. Their description of the lesion in question coincides with my observations and emphasizes further the importance of recognizing this type of acute mastoiditis—the acute hemorrhagic type—since in its clinical picture, its course, its roentgen manifestations and its sequelae it is entirely different from the acute coalescent mastoiditis.

Fungus infections of the external auditory canal occur more frequently in warm damp climates than in our own country. However, cases of otomycosis are occasionally seen here, and the reports of Wilson,[16] Fort [17] and Gordon [18] are timely. When produced by one of the group of *Aspergilli,* the lesion presents itself clinically as a severe itch with a discharge from the external auditory canal. Examination shows the canal filled with black or greenish spots and long threads, with the skin underneath raw and thickened. Treatment consists of the use of a cleansing douche, followed by the instillation of a 2 to 5 per cent solution of salicylic acid.

Infantile otitis media was studied again by Lierle,[19] who found that all his cases were secondary to infections in the nose and throat. Paranasal sinusitis was found in all but six of the cases. Ninety-two showed a bilateral aural involvement. Clinically, only a few presented any pathologic process in the membrana tympani. It is noteworthy that Lierle failed to obtain a flow of pus after paracentesis; but antrotomy gave pus under pressure which, when cultivated, yielded *Streptococcus hemolyticus.* This observation to some extent bears out the early literature on otitis media purulenta in infancy. Gompert, Preysling, Kopetzky and others called attention to the intact drumhead and explained this as due to the short, straight, open character of the eustachian tube in infancy, which permits the discharge of the pus into

14. Beyer, H.: Grippe otitis, Ztschr. f. Hals-, Nasen- u. Ohrenh. **21**:51, 1928.

15. Keogh, P. J.: Some Otitic Complications of Influenza, Irish J. M. Sc. **2**:670, 1927.

16. Wilson, F. L.: Report of a Case of Otomycosis, Nebraska M. J. **13**:21, 1928.

17. Fort, A. G.: Otomycosis, J. M. A. Georgia **17**:8, 1928.

18. Gordon, J. K.: An Outbreak of Otitis Media (Otomycosis) at Gatun Lake, Canal Zone, U. S. Naval M. Bull. **26**:468, 1928.

19. Lierle, D. M.: Otitis Media in Infants, Ann. Otol. Rhin. & Laryng. **36**: 604, 1927.

the pharynx. Lierle's observation differs from theirs in that he failed to find pus in the middle ear spaces. It may be that the period at which Lierle's observations were made accounts for the discrepancy between his observations and those of the other observers quoted here. In the earlier stages of the disease, one can conceive of the confinement of the purulent exudate to the antrum, before the pus burrows its way through the thickened reduplications of the membrane limiting Prussack's space to the middle ear proper. The current tendency to earlier operation in infantile otitis media gives a view of the lesion at an earlier stage than formerly, when these cases came to operation late in their course. Lierle's observation merits further study.

Two reports were made on the prevention of chronicity in disease of the middle ear by an early resort to surgical measures. MacKenzie [20] laid particular emphasis on the conservation of hearing in acute lesions of the middle ear by early treatment and operation to prevent chronicity. For the same reason, he warned against hasty paracentesis in cases of acute catarrh. McFarling [21] also stressed avoidance rather than cure. Like MacKenzie, he advised early operation to prevent chronicity and the concomitant loss in hearing. I am in accord with these views and with the reasons underlying them.

CHRONIC OTITIS MEDIA

In experimental production of a cholesteatoma, Berbereich [22] found that the epithelium of the posterosuperior wall of the canal proliferates first into the attic and antrum, where it consists of a fat-containing connective tissue composed of cholesterol crystals. In rabbits, he found that the squamous epithelium of the canal invades the middle ear through both central and marginal perforations. This is of interest and will be discussed again in regard to another article.

In this connection, Nienhaus [23] found that the squamous epithelium in rabbits had destroyed the cylindric epithelium of the middle ear by growing from the depth toward the surface. After it reached the surface, it proliferated under the cylindric epithelium, thus destroying the latter. This supports the opinion of Manasse, Lange and Hellman that the development of a cholesteatoma is attributable to a change in the nature of the cells in the squamous epithelium of the outer ear.

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20. MacKenzie, G. W.: Acute Inflammation of the Middle Ear in Children, J. Ophth. Otol. & Laryn. **32**:1 (Jan.) 1928.

21. McFarling, A. C.: Chronic Otorrhea, J. Oklahoma M. A. **21**:147, 1928.

22. Berbereich: Das experimentelle Mittelohrcholesteatom, Ztschr. f. Hals-, Nasen- u. Ohrenh. **18**:311, 1928.

23. Nienhaus, J. H.: Beitrag zur Kenntnis über das Entstehen des Mittelohrcholesteatoms. Eine Beobachtung beim Kaninchen, Ztschr. f. Hals-, Nasen- u. Ohrenh. **19**:186, 1927.

Lautenschläger [24] studied the epithelial pearls of the normal skin and came to the conclusion that clinically and anatomically they are of the same structure as a cholesteatoma. In the development of these epithelial pearls, all the stages of the development of a cholesteatoma are seen. Growth of the epithelial pearls goes on in the abscence of any prior suppuration or other irritating agent.

These studies on the ever interesting question of cholesteatoma add nothing of practical value, but they help toward a better comprehension of the nature of the lesion. The observation that a cholesteatoma may develop from a central perforation injects a new factor into the determination, from otoscopic examination, the danger of a given condition. However, even if Berbereich's study stands and central perforations, which have heretofore been viewed as designating a nondangerous type of chronic otitis media purulenta, come to be regarded as sites for the development of cholesteatoma, it still remains clinically true that a cholesteatoma is almost always found associated with the marginal type of perforation. It may be that the experimental work of Berbereich describes a preclinical stage of the lesion which it is impossible to recognize otoscopically. However, Waltke [25] bore out Berbereich in the presentation of a case of cholesteatoma which had a central perforation. While he conceded the rarity of this, Waltke cited similar instances which have been recorded by Uffenorde and Ulrich.

Keen [26] compared the various methods used in the treatment for chronic otorrhea. For this study, he divided his cases into two groups. Without discrimination, patients were alternately assigned to be treated by the ordinary methods (drops, irrigations, boric powder, etc.) and by zinc ionization. There were thirty-nine cases in each group. In each division thirty-four were remedied and five were not. He concluded that the only advantage presented by the zinc ionization is the rapidity with which it clears up the discharge.

While such studies give interesting data, as I have repeatedly stated in these summaries, they are useless from the scientific point of view, unless the observer either describes each case so minutely that its exact classification is apparent to the reader or himself classifies the clinical material that he submits to a given therapeutic test. Chronic otorrhea, for example, is a symptom common to a number of lesions of the middle

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24. Lautenschläger, A.: Epithelperle und Cholesteatom, Ztschr. f. Hals-, Nasen- u. Ohrenh. **21**:314, 1928.

25. Waltke, H. H.: Ist es berechtigt lediglich, aus der Lage der Trommelfellperforation eine absolut sichere Prognose über die Ungefährlichkeit beziehungsweise Lebensgefährlichkeit chronischer Mittelohreiterungen zu stellen, Ztschr. f. Laryngol., Rhinol. **16**:107, 1927.

26. Keen, J. A.: The Treatment of Otorrhea, with a Comparison of the Various Methods, Practitioner **121**:35, 1928.

ear. What is wanted are the results obtained with a given therapeutic agent in a given lesion, not those in connection with a symptom common to a number of lesions.

The modified radical mastoid operation was again recommended by de Lamothe [27] for cases in which the chronic suppuration is confined above Shrapnell's membrane and in which the ossicles are intact. Here, too, the classification of the type of chronic lesion in the mastoid process would add considerably to the value of the report.

Chapman [28] discussed the incidence of tuberculosis of the middle ear in Colorado. He reported the ratio of tuberculous otitis to be about six to every hundred cases of tuberculosis. The onset of the otitis is insidious; pain is rarely present; there is little if any redness of the drum, and the discharge is seropurulent. Facial palsy is a common complication. The diagnosis is made from the characteristic onset, the chronicity, the adjacent tuberculous lesion and the results of the inoculation of guinea-pigs. Heliotherapy offers the best results.

SINUS THROMBOSIS

Beck [29] studied the histologic changes that took place at the site of the compression of the sinus by a gauze plug. The outer wall of the sinus that was compressed showed a leukocytic infiltration. This infiltration extended to the inner layer, which had become denuded of its endothelium at the site of compression. Directly at this point, the lumen of the sinus was completely gone, and only in a few places was there any evidence of the space between the mesial and the outer wall of the sinus. The outer layers of the wall in contact with the plug compressing it were infiltrated with pus; but the rest of the walls of the sinus were free from any reaction. The mesial wall of the sinus remained normal. The endothelium on the mesial wall remained intact. The destroyed endothelium on the outer wall was replaced by a network of fibrin which united the two walls in an effort to obliterate the lumen of the vein. This picture was obtained in a human being eleven days after compression of the sinus. In a further study of the sections, Beck noted that the fibrinous membrane had the croupous appearance found in other places in the respiratory mucous membrane. This observation does not fit in with the usual histologic conception of a thrombosis. He further observed that the intensity of the inflammation and the thickness of the

27. De Lamothe: Résultat eloigné de quatre cas d'evidement partiel (opération de Bourgeois-Sourdille), Ann. de mal. de l'oreille, du larynx **46**:1123, 1927.

28. Chapman, S. J.: Tuberculosis of Middle Ear with Special Reference to Heliotherapy, Ann. Otol. Rhin. & Laryng. **36**:631, 1927.

29. Beck, O.: Histo-pathologische Veränderungen am Sinus sigmoideus des Menschen hervorgerufen durch Kompression, Acta oto-laryng. **12**:228, 1928.

masses of fibrin were most marked at the point where the circulation was stopped. This also does not fit in with the usual conception of a thrombosis. It is more like an inflammatory process. It gave Beck the impression that otogenic sinus thrombosis is an exudative plastic inflammation rather than a true thrombosis emanating from the outer wall. Compression thrombosis seems not to be a real thrombosis, but a true endophlebitis.

This observation is important from a number of points of view. Thrombosis per se is regarded as a defensive mechanism, nature's effort to circumscribe an infection entering the blood stream through the wall of a vein. The situation in the experiment conducted by Beck is not strictly analogous to what happens in nature when an infection reaches the sinus wall through the osseous tissue which constitutes the mastoid process, except perhaps in those cases in which an unrelieved perisinal abscess exerts continuous pressure on and causes compression of the sinus wall. In all other conditions, the accepted view is that trauma and infection of the intima produce an inflammatory reaction which is eventually surrounded by a thrombotic deposit.

Despite this, Beck's study gives data of value. Heretofore there has been no scientific reason adduced to explain why, in some cases, when operation on the lateral sinus has taken place and the proximal and the distal ends have been plugged off, an obliterating thrombus fails to form at the site of the plugs. Usually, one can remove the plugs with safety after from five to seven days. In an occasional case, however, clotting fails to take place in the vein for a much longer time. In my own cases, this has presaged an unfavorable outcome. At operation, the surgeon has proceeded beyond the area macroscopically ascertainable as diseased and has placed his plugs in the wall of the vein on what he believed was normal tissue. On removal of the plugs five or seven days later, the vein still bleeds and no obliterating clot has formed. Beck's experiment gives a reason for this. The endophlebitis has extended beyond the area macroscopically discernible as diseased; and he has proved that no clot forms in the vein at the site of endophlebitis. It follows from this that when such a condition is presented in a given case, immediate efforts should be made to work back farther along the wall of the vein and seek obliteration of the lumen at a spot more distant from the site of the infection; for the area involved in the endophlebitis contains the same threat of an infection of the blood stream and secondary foci as the original lesion.

In a discussion of otitic sepsis, Crane [30] stated that when sepsis is present, the internal jugular vein should be ligated first, regardless of

30. Crane, C. G.: Septicemia Secondary to Acute Middle Ear Disease, Laryngoscope **38**:107, 1928.

the apparent condition of the sinus. According to him, it is of secondary importance whether the sinus is opened or not. Yet he reported among seven cases two with the history and finding of sinus thrombosis and with a positive blood culture of hemolytic streptococcus, in which operation on the sinus or jugular vein was not done, and the patients recovered. Case 7, in which a bilateral mastoidectomy had been done, required reoperation for persistent fistula of the right wound. At the second operation, the right lateral sinus was found to be solid, and a large part of the outer wall was absent. Crane remarked that the thrombus had apparently become organized, and that complete obliteration had occurred. What probably happened was that the outer sinus wall had ruptured, discharged its septic and thrombotic contents into the mastoid wound and become eviscerated; and nature sealed the distal and proximal ends of the diseased vein with a protective thrombosis. I have operated on patients seen late in the course of a sinus thrombosis and found a similar situation. Crane's contentions are not in accord with his reported observations; nor do they find support in the conclusions of most otologists.

Krepuska [31] studied the necessity for jugular ligation in 295 cases of sinus thrombosis. In 196 of these cases, the patients recovered. Of those who recovered, 138 had no surgical tying of the internal jugular vein. Of the 99 who died, 25, or one fourth, had no ligation of the jugular vein; whereas 74 died despite ligation. He made the observation that the decision for ligation of the jugular vein should be based on each case individually, partly on the clinical course and partly on the pathologic observations at operation. This is the only rule possible in deciding such an important question. I feel that it is much more important to rid the lateral sinus of the focus of infection, tying the jugular vein in all cases except those in which there is an obliterating clot.[32]

Hirsch,[33] in a report of thirteen cases of sinus thrombosis, mentioned nine patients who recovered, four of whom had no ligation of the jugular vein. Of the four who died, three had a ligation of the jugular vein. He tied the internal jugular vein when a thrombophlebitis of the vein itself was found, when thrombosis of the bulb was present and as a last resort in severe sepsis with metastases. The conflicting views presented are in themselves proof that each case is an entity in itself and cannot be governed by fixed rules.

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31. Krepuska, G.: Ueber otogene Pyämie mit besonderer Berücksichtigung der Frage der Jugularisunterbindung, Ztschr. f. Laryngol., Rhinol. **17**:176, 1928.

32. Kopetzky, S. J.: Studies in Otitic Sepsis, Ann. Otol. Rhin. & Laryng. **37**:929, 1928.

33. Hirsch, M.: Zur Frage der Jugularisunterbindung bei Sinusphlebitis, Ztschr. f. Laryngol., Rhinol. **17**:110, 1928.

Beyer [34] discussed the question of otitis pyemia without sinus thrombosis. He alleged that the pathologic condition termed osteophlebitic thrombosis by Körner is no longer accepted as an independent entity since there is no pathologic evidence to support it. Technically, this is true; yet Körner's work stimulated the study of a group of cases which yielded remarkably good results when submitted to the therapy that he outlined. While, pathologically, no thrombi are found in the blood vessels running through the osseous structure itself, thrombosis does take place in the venules of the lining membrane of the mastoid cells; and these multiple septic thrombi constitute a grave danger to life. Such cases comprise a group of lesions which numerous observers, among them Joseph C. Beck,[35] noted, and which have been the subject of detailed study by me. Their outstanding characteristic, as noted also by Beyer, is pyemia without a macroscopically evident lateral sinus thrombosis.

This critique would be incomplete if certain of the observations in Beyer's case reports were allowed to go unchallenged. In his case 1 there was a pneumococcus, type IV, in the mastoid process and in the blood, and there was meningitis. In this case, one would find ample reasons for the pyemia outside of the scope of Beyer's argument. Furthermore, in his case 3, an acute arthritis of the left ankle was present prior to mastoidectomy. This case presented marked pyemia, and the patient recovered without surgical treatment of the internal jugular vein or the lateral sinus. Many cases in which similar observations were made have been reported by Körner, Beck and myself. The importance of recognizing the type of acute mastoiditis described by Joseph Beck as thrombotic mastoiditis and by me as hemorrhagic mastoiditis lies in the fact that through early surgical intervention in the mastoid, operation on the blood vessel itself is often made unnecessary. I do not think that the majority of otologists agree with Beyer that there are no signs or symptoms pathognomonic of sinus thrombosis.

Maybaum and Goldman [36] reported nine cases of primary thrombosis of the bulb and stressed the necessity for obtaining free bleeding from the torcular end of the sinus in view of Ottenberg's differential blood cultures, wherein the greatest growth was obtained from the jugular vein on the healthy side. I commend their conclusion, although I do not accept the premise on which it is based. The nearer one approaches healthy tissue at the torcular end, the freer the resulting bleeding before

34. Beyer, T. E.: Otitic Pyemia Without Sinus Thrombosis, Laryngoscope **38**:785, 1928.

35. Beck, J. C.: Applied Pathology in Diseases of the Nose, Throat and Ear, St. Louis, C. V. Mosby Company, 1923, pp. 79-81.

36. Maybaum, J. L., and Goldman, I. B.: Primary Jugular Bulb Thrombosis, Laryngoscope **38**:569, 1928.

the final plugging; and the reasons that I advanced in discussing Beck's experiment hold true here. Ottenberg's observations are not yet sufficiently established and substantiated to constitute a basis for the formulation of any general principles of surgery.

Primary thrombosis of the bulb of the jugular vein is more often present and is more frequently the cause of sepsis in early childhood than is generally realized. While otologists usually recognize the condition and comprehend the therapy needed, the pediatricians under whose observation these children come lack acquaintance with the lesion, its significance and the mechanics of its development. It is gratifying to note that Reuben [37] presented a report on the subject to the pediatricians.

Lillie [38] discussed the indications for blood transfusion and recommended it for those cases in which the temperature remains persistently septic and there is an increasing anemia. In cases in which the temperature remains persistently septic, I have not found transfusion of any avail in altering it. This indicates that the septic focus has remained unrelieved, or that inaccessible metastatic lesions have formed. Transfusion gives temporary relief in anemia and is indicated for this. It will not cure the patient of sepsis unless the offending foci have been removed. Often repeated transfusions dilute the antibody contents of the patient's blood and are a hindrance rather than an aid to speedy recovery. When the septic focus has been removed and it is desired to furnish blood elements to an exhausted body, transfusion has undoubted value. As in all therapy, less stress on generalizations and a more detailed study of the needs in the individual case furnish the real clue to usage.

51 West Seventy-Third Street.

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37. Reuben, M. S.: Primary Sinus Thrombosis, Arch. Pediat. **45**:98, 1928.

38. Lillie, H. I.: General Sepsis of Otitic Origin, Arch. Otolaryng. **7**:30 (Jan.) 1928.

News and Comment

AMERICAN LARYNGOLOGICAL, RHINOLOGICAL AND OTOLOGICAL SOCIETY

Dr. Ross Hall Skillern of the Graduate School of Medicine was elected president at the recent convention of the American Laryngological, Rhinological and Otological Society held in San Francisco, July 4 and 5.

This society is composed of the leading specialists of the United States and Canada in Otolaryngology and has a membership of nearly five hundred. The next meeting will probably be held during the latter part of May, 1930, in Atlantic City, N. J.

Obituary

CHARLES WILLIAMSON RICHARDSON, M.D.

1861-1929

In the death of Dr. Charles Williamson Richardson on August 25, the medical profession lost one of its best known and most skilful practitioners, and Washington, one of its illustrious citizens. Although he had been ill for months, Doctor Richardson attended every meeting of the Board of Trustees of the American Medical Association during the Annual Session at Portland, Ore., in July. After the meeting he left for his summer home at Duxbury, Mass., stopping over at the Massachusetts General Hospital in Boston to undergo an operation for an intestinal condition.

Doctor Richardson was born in Washington, D. C., Aug. 22, 1861. He graduated in medicine from Columbian, now George Washington, University, and the University of Pennsylvania in 1884, and did graduate work in surgery at Vienna and Goettingen, under Schnitzler, Stoirk, Schroetar, Chiari and Beregzaszy. Returning to Washington, he began practicing as a specialist in nose, throat and ear diseases. He attained great distinction, having had among his patients several presidents of the United States and other notable persons.

Doctor Richardson's scientific contributions included numerous articles in the periodic literature and special sections in Musser and Kelly's "Handbook of Practice and Treatment," the "Reference Handbook of the Medical Sciences," and in Posey and Wright's "Diseases of the Eye, Ear, Throat and Nose." A recent contribution was a survey of institutions for the deaf to aid in determining the causes of deafness, conducted by a committee of specialists, of which he was chairman, under the auspices of the National Research Council. From 1891 to 1924 he was professor of laryngology and otology in George Washington University, and at the time of his death he was professor emeritus. He was also on the staff of several local hospitals.

Doctor Richardson was foremost in the cause of organized medicine. He was president of the Medical Society of the District of Columbia in 1904, and one of the sponsors of its new building. He raised one fourth of the funds and was presiding officer at its dedication. Doctor Richardson was chairman of the Section on Laryngology, Otology and Rhinology of the American Medical Association in 1925, and was a member of the Board of Trustees of the Association for nine years preceding his death. He had yet two years before completing his term

of office. He had been president of the American Otological Society, the American Laryngological Association, the American Laryngological, Rhinological and Otological Society and the American Climatological and Clinical Society, and had been a delegate of scientific organizations to congresses in this country and abroad. He was a fellow of the American Academy of Ophthalmology and Otolaryngology, the American College of Surgeons, the Washington Academy of

CHARLES WILLIAMSON RICHARDSON
1861-1929

Science and Associated Societies, and the Academy of Social Science; a member of the International Tuberculosis Association, and a director of the American Association to Promote Teaching of Speech to the Deaf. He was awarded the honorary degree of Doctor of Science by his alma mater in 1921, and by the University of Pennsylvania in 1927. During the World War, Doctor Richardson was commissioned major in the Medical Reserve Corps. He was promoted to the grade of colonel in the National Army, serving as director of the section on

defects of hearing and speech in the Surgeon-General's Office, and was colonel in the Reserve Corps when he died. Outside of the medical profession, Doctor Richardson was a member of The Fossils, a unique organization with a membership of several thousand, which represented a group of more than sixty boys who long ago were editors and publishers of little papers in which everything was discussed. This truly boyish activity almost ceased to exist in the eighties, and to keep the memories the once youthful editors incorporated their society. Some of the best known men in our country belonged to The Fossils. Doctor Richardson was president of this organization in 1927. He was also a member of the Sons of the Revolution, the Military Order of the World War, and of the Cosmos, Chevy Chase and the Army and Navy Clubs. He was a trustee of the New York Avenue Presbyterian Church. He truly lived a useful life. At his side at the last were his widow and daughter, besides whom he is survived by two sisters and five grandchildren.

Abstracts from Current Literature

Ear

SMALL TUMORS OF THE ACOUSTIC NERVE. W. LANGE, Ztschr. f. Hals-, Nasen- u. Ohrenh. **23**:1 (March 23) 1929.

Whereas it was thought formerly that in a case of tumor in the cerebellopontile angle the growth that filled the dilated inner meatus was part of the tumor grown into the meatus, Henschen (1910) said that the reverse was true, namely, that the tumor originated in the meatus and grew into the cerebellopontile angle. Henschen laid stress especially on small tumors found accidentally in necropsies. Lange describes two such tumors: one in a man, aged 71, who died of apoplexy, and one in a woman, aged 77, who died of cerebellar apoplexy. The author speaks of the well known difference in the structure of the tumors of the acoustic nerve. This difference is noticeable also in small tumors which do not show a secondary degeneration. How can this difference be explained? Verocay, Henschen and Krahn have expressed their views on this subject, with which the author agrees. The tumors of the acoustic nerve develop from undifferentiated nerve cells, which progress either toward a gliosis or toward the development of the nerve cell and its fibers. In small tumors, the difference can still be seen clearly. Abnormal forms of growth, secondary degenerations and reactive proliferation of connective tissue make the picture more complicated. It can also be imagined that a small tumor presents a mixture of the two forms. Then, the picture of the large tumors will be still more complicated.

VALUATION OF RESULTS OF THE CALORIC REACTION, ESPECIALLY IN MÉNIÈRE'S DISEASE. KLAUS VOGEL, Ztschr. f. Hals-, Nasen- u. Ohrenh. **23**:39 (March 23) 1929.

1. In the cases of traumatic and nontraumatic Ménière's disease, if differences of vestibulary irritability existed between the two sides, there was a more pronounced excitability of the nystagmus toward the side of the preponderating vestibulary system. It did not matter whether the nystagmus was created by cold irrigation of the one side or by hot irrigation of the other side.

2. In the cases reported (twenty-five), the result of hot irrigation was referable to the vestibulary system of the same side, the result of cold irrigation to that of the opposite side, provided that one or both labyrinths or the nerve trunk was not completely nonirritable.

3. A ready tendency toward nystagmus, formed by combined examinations with cold and heat, toward the side of the preponderating vestibulary system, could also be established regularly by rotatory and galvanic irritation, if differences had been present in these tests.

4. In two cases of tumor in the posterior fossa, in three cases of multiple sclerosis and in one case of syringobulbia, the same ready tendency toward nystagmus could be observed.

5. Five patients with undoubted disturbances in the peripheral labyrinth did not show any predilection in the direction of the nystagmus but a hypo-excitability for hot and cold on the diseased side, namely, for stimuli which incite nystagmus toward different directions.

6. The author could not show such a phenomenon in his patients suffering from traumatic and nontraumatic Ménière's disease or from multiple sclerosis, syringomyelia or tumors of the posterior cranial fossa.

7. A possible difference of the drum membrane and of the middle ear (namely, of the condition for caloric conduction) does not play any part in the judgment of the tonus equilibrium of both vestibular apparatuses (in cases of caloric-demonstrable readiness for nystagmus to one side by hot or cold irrigation), because an impediment of heat conduction may simulate only a bilateral hypo-excitability for hot and cold, but not a ready tendency for nystagmus.

EXPERIMENTS CONCERNING THE FUNCTION OF THE OTOLITH APPARATUS IN MAN. F. H. OUIX and M. H. P. M. EIJSVOGEL, Ztschr. f. Hals-, Nasen- u. Ohrenh. **23**:68 (March 23) 1929.

The investigations of the authors were made for three reasons: to learn whether the otolith apparatus participates in the perception of the position of the body with regard to the vertical line; to learn whether reflexes are caused in man as in many animals which keep the head unchanged in its position with regard to the vertical line when the body assumes a different position in space, and, lastly, to learn how the past-pointing test is carried out in positions of the body characterized by certain relations to the otoliths (positions of maximum and minimum pressure). The investigations are reported under three heads: (1) perception of the position of the body in reference to the vertical line; (2) labyrinthine reflexes on the neck in changes of position of the body, and (3) the past-pointing test in various positions of the body. The article should be read in the original. Only a few items may be mentioned. The authors used Aubert's apparatus, and they mention the observations of several other authors: Delage, Aubert, Sachs and Meller and Karl Grabe. They experimented on twenty students. Turning, they found, must be slow, so that the semicircular canals will not be irritated. An athlete among the students mentioned some experiences which are known to occur when one is performing the shoulder stand on the high horizontal bar. The head is thrown toward the neck, and a pronounced overstretching of the body and the extremities results. In this manner, it is easy to keep the equilibrium. When the eyes are closed, it becomes difficult to preserve the equilibrium, and swinging motions of the body result. If the head hangs between the arms (with eyes open), only experienced athletes can perform the shoulder stand on the bridge. After closing the eyes, the athlete showed that the equilibrium could not be kept so easily; swinging motions of the body set in. One is conscious of the position of the head and the body. The relation to the vertical line is almost exactly appreciated up to 60 degrees in a backward rotation around the bitemporal axis with head fixed, and in a forward rotation, up to 90 degrees. After that, the movements are overestimated. In turning backward from 120 to 135 degrees, the sensation of standing on the head occurs. In turning forward, this sensation occurs at 140 degrees. The question arises: Through which sense organs is the perception of position created? It is caused by a complex of impressions of sense organs. The eye is most responsible and then the sense of touch, namely, surface sensibility, deep sensibility, the muscle tendon and joint sensibility, etc. The otolith organs participate in the complicated perception of the position of the head in space. Furthermore, if one holds the body of an animal in the hand while the head remains free in the air, and if one turns the body backward around the transverse axis, the head turns around the bitemporal axis forward. If the body is turned around its long axis to one side, the head turns around the sagittal axis of the head to the other side. By virtue of this counter movement of the head, the head preserves as much as possible an unchanged position toward the vertical line. After a bilateral extirpation of the labyrinth, this reflex counter movement of the head disappears. Therefore, it must be a labyrinthine reflex. The compensatory counter rotation of the head in changed body positions does not occur in man. Only a counter rotation of the head around the vertical axis was noticed when the body was turned around the sagittal axis. The counter rotations cannot be regarded as compensatory in the sense that the position of the head toward the vertical plane remains constant.

In regard to the investigations concerning the past-pointing test in various positions of the body, the authors came to the conclusion that, even if the normal relation between otolith and neck reflexes is discontinued, exact pointing exists in the arm of the side on which the regulating otolith is under pressure, but that past-pointing occurs in the arm on the side on which the otolith is not functioning. The capilli are synergists; they move each arm in the same direction, the arm on the same side mostly more than the other, in the horizontal line. Pressure of the capilli on the maculae increases the tonus of the flexor muscles, and weakens the tonus of the extensors, whereas decrease of pressure has the opposite effect. The maculae sacculi move the extremities in the vertical frontal plane: In the normal position, the abductor and adductor muscles come into play. Increase of the pressure of the sagittae on the macula moves the arm of the same side, when it hangs vertically downward, toward the outside (laterally), and the arm of the other side inwardly. Decrease of the pressure has the opposite effect. The sagittae are antagonists. For testing the capilli, the head is bent 75 degrees backward; thereby the pressure of the capilli on the maculae becomes zero. Then the head is bent 30 degrees forward from the vertical line, which causes a maximal pressure. For testing the sagittae, the head is turned first about 75 degrees to the right shoulder, and, secondly, 75 degrees to the left shoulder. In the first case, the pressure of the right sagittae is zero, that of the left 75 per cent of its maximum. The past-pointing test is carried out without great mistakes for the capilli and the right and left sagittae in the sitting or standing positions. In both instances, two factors influence the past-pointing test: first, the otoliths, and second, the neck reflexes. Each has different values in the two positions, but they are closely related to each other. When the head is turned on the neck around the bitemporal axis and around the sagittal axis, the otolith pressure and the sensibility of the neck are changed in fixed relations. The function of the otolith makes correct past-pointing possible even if the normal relation to the neck reflexes is interrupted. If the otolith does not function, the past-pointing test is unsuccessful. If the past-pointing test is carried out while the head is in the blind spot, all tests are negative. The mistakes are so great that no regularity can be detected. It is important to note that the past-pointing test, with the head fixated, can be carried out exactly only with the head in certain positions. In other positions, physiologic past-pointing is present.

THE FUNCTION OF MUSCULUS STAPEDIUS IN MAN. E. LUESCHER, Ztschr. f. Hals-, Nasen- u. Ohrenh. **23**:105 (June 10) 1929.

The author had occasion to make the following observations on a boy, aged 17, who suffered from a defect of the right drum membrane after a box on the ear: 1. The tendon of the stapedius could be observed in an otherwise normal hearing organ through a nonirritated defect in the drum, with the aid of the otoscope. 2. The stapedius muscle in man shows regular and constant cochlear reflexes, which can be elicited with about the same intensity from the homolateral and the other ear. 3. With pure tones, the reflex occurs only in a certain tone field. The tone field in the patient was located between 90 and 14,000 vibrations. 4. The tone must have a certain intensity and pitch. When the intensity increases twitching sets in; at last, however, permanent contraction occurs, which ceases only when the tone ceases. 5. Noises elicit the reflexes much more easily than pure tones. Twitching may be caused, for instance, by the conversational voice at a distance of 50 cm. from the ear, by a slight blowing sound at the ear, by a slight sounding of the tuning fork or by other stimulation. The reflex seems to respond to those irritations that affect the ear in daily life. It is so delicate that it must be almost always in action in daily life. 6. The reflex occurs the more easily, the stronger, the higher and the more noisy the sound is. 7. The reflex can be excited also by the mere expectation of a strong sound irritation. Yet, the expectation must be caused in the sense of a conditioned reflex; the reflex cannot be brought about merely by voluntary listening. 8. The reflex can also be caused by inadequate

irritations; for instance, by pricking the auricle. 9. The stapedius muscle does not participate even in the violent voluntary contraction of the muscles innervated by the facial nerve. A voluntary contraction of the stapedius could not be established. 10. The contraction of the stapedius seems to be almost isometric. It does not affect the drum. 11. All observations point to the fact that contraction of the stapedius muscle causes a decrease of sound transmission and thereby a decrease of the function of the ear. Therefore, the stapedius is not a muscle facilitating listening, but a protective mechanism which has the task of warding off from the sound perceiving apparatus too strong sounds, automatically, by a reflex action, in order to prevent injuries. The results of the corresponding experiments on animals by Kato (*Arch. f. d. ges. Physiol.* **150**:569, 1913) are applicable also to the human organ of hearing in all details. (The reviewer wishes to call attention to the importance of this contribution in connection with the efforts toward the abatement of noise.)

MOBILIZATION OF THE OSSICLES OF THE EAR IN ORDER TO IMPROVE HEARING. M. SCHIRMUNSKY, Ztschr. f. Hals-, Nasen- u. Ohrenh. **23**:137 (June 10) 1929.

In cases of pronounced hardness of hearing, in consequence of a suppuration of the middle ear, mobilization of the ossicles is indicated if partial or total destruction of the drum membrane and formation of scar tissue in the tympanic cavity have led to fixation of the ossicles and if other methods of treatment do not effect an improvement in hearing. The result of the operation can be predicted with a certain probability if the result of the Rinne test with a series of tuning forks is strongly negative. A longer perception in bone conduction than in that of the normal ear (Schwabach's test) cannot be shown in cases of a former suppuration of the middle ear, because the sound perceiving apparatus is almost always affected in pathologic processes of the middle ear. The following types of adhesive processes after healing of a suppuration of the middle ear are easily accessible to surgical intervention and furnish the indication for mobilization of the ossicles in order to improve the hearing:

1. Adhesion of the lower end of the malleus handle to the promontory, whereby the incus and the stapes are drawn inward losing the power to vibrate, and giving rise to pronounced hardness of hearing.

2. Cicatricial adhesions of the drum membrane to the inner wall of the tympanic cavity in which the malleus is drawn inward and fixed to the incus and stapes by cicatricial tissue. After severing of the cicatricial tissue between the malleus and the long process of the incus, a vertical incision is made immediately in front of the malleus, and its handle is drawn forward with a dull hook.

3. Cicatricial adhesions of the rest of the upper part of the drum membrane to the malleus. After the drum membrane has been severed on both sides from the malleus, the handle of the malleus is mobilized and thereby the incus and the stapes, which are retracted inward, are freed from their tension. This operation is indicated in those cases of destruction of the drum membrane with conservation of the upper part, in which improvement of hearing results from the introduction of a little cotton ball. Mobilization of the ossicles has the same result.

If the cicatricial process has ceased long ago, the scar tissue is poor in blood vessels, so that a renewed fixation of the ossicles does not appear to be possible, especially, if the malleus is pulled forward with a dull hook. In cases in which the tympanic cavity is not entirely epidermized, the author places a piece of the skin of an egg between the mobilized malleus and the promontory.

The author has mobilized the ossicles in twenty persons who were very hard of hearing. In all cases, a more or less pronounced improvement of hearing and the cessation of tinnitus have resulted. He uses for the operation: (1) the small knife of Politzer, rounded at its anterior part; (2) a dull little hook, and (3) a small knife which is bent at a right angle to the flat, and which cuts horizontally with the lower sharp edge. The first instrument serves to sever the cicatricial tissue, the second to retract the mobilized malleus, and the third is carried behind

the malleus in order to loosen, with its sharp downward cutting edge, the malleus handle from its adhesions to the promontory. As an anesthetic, a 10 to 20 per cent cocaine solution with a few drops of solution of epinephrine (1:1,000) was used. Of the twenty cases, seven of greater interest are reported in detail. The author concludes that mobilization of the ossicles and artificial perforation of the drum membrane are the only reliable methods of improving the hearing in pronounced hardness of hearing after the healing of a suppuration of the middle ear. Politzer advised the mobilization of the ossicles for this purpose in 1884. The author asserts that Politzer neglected to draw a sharp line between cases in which mobilization of the ossicles does not offer technical difficulties and in which a recurrence of the adhesions can be excluded to a certain degree, and cases in which the mobilization of the ossicles requires complicated technical manipulations, such as separation of the shanks of the stapes or of the long process of the incus, which may cause a reactive inflammation, with its consequences, namely, the return of the adhesive process.

RELATION BETWEEN MINERS' NYSTAGMUS AND VESTIBULAR TURNING NYSTAGMUS. I. OHM, Ztschr. f. Hals-, Nasen- u. Ohrenh. **23**:153 (June 10) 1929.

After investigations lasting for twenty years, Ohm assumes that the ventrocaudal Deiters' nucleus takes up vestibular, optic and voluntary irritations, and that it sends a large number of periodic discharges to the muscles of the eye. The mechanism is termed by the author "eye muscle dispatcher." Under ordinary circumstances, these discharges cannot be noticed, on account of their high frequency and small amplitude. They become noticeable only if the frequency falls below a certain threshold and the amplitude becomes larger. Then, they are called nystagmus. The author reports four cases of the many at his disposal, and comes to the following conclusions: 1. At the beginning of rotation, in the light, the vocational nystagmus is almost immediately replaced by the vestibular turning nystagmus. Sometimes, however, it can be demonstrated in its slow phase. When the vocational nystagmus becomes invisible, it can reappear during rotation if the frequency of the vestibular nystagmus decreases. The latter governs the picture the sooner, the more it surpasses the vocational nystagmus by its amplitude. During turning in the dark, however, the vocational nystagmus can be well recognized in the slow phase of the vestibular nystagmus. 2. After turning in the light, the vocational nystagmus predominates. Sometimes it is intermingled with little vestibular after-nystagmus. But in the dark, after rotation, a lively vestibular after-nystagmus is mixed with the vocational nystagmus. This vestibular after-nystagmus stands sometimes in the foreground, after stopping, and it declines gradually. 3. The supplanting of the vocational trembling can be very different in turning to the right from that in turning to the left. 4. In one case, turning in the light and dark seemed to produce a small decrease in frequency of the vocational nystagmus. 5. At times, an attack of vocational nystagmus can be excited by a certain way of rotation (case 4). 6. The former results found by the author concerning the vestibular nystagmus (*Ztschr. f. Hals-, Nasen- u. Ohrenh.* **16**:521 1925; **17**:259, 1926; **19**:87 and 467, 1927) have been confirmed; namely, that the vestibular turning nystagmus is greater and more frequent in the light than in the dark. In the light, an after-nystagmus follows almost never with slow turning, but is lively in the dark. The cases reported here show that in the eye trembling of miners, after turning in the light, an after-nystagmus occurs sooner than in otherwise quiet eyes. Concerning the finer processes in the central nervous system, the author concludes that the vocational nystagmus does not cease during turning. It is only covered up, because its small amplitude does not show itself compared with the coarse vestibular turning nystagmus. Many observations in the slow phase show that it lies like a fine curling on the large vestibular waves. The vocational and vestibular contraction waves in the eye muscles do not merge as do the tones in the sound tracings. The tracings point to the fact that the condition of irritation of the ganglion cells which causes vocational trembling of the eyes is changed by vestibular irritation, after which it sends out other vibrations.

Finally, the author sees his theory of the jerking nystagmus confirmed by these investigations. This theory emanates from analysis, and shows that the jerking nystagmus can be explained mathematically by pendulum vibrations of various rhythmic frequencies. The tracings reported in this article consist of a mixture of vocational and vestibular nystagmus, and are similar to some complicated tracings of miners' nystagmus. It must be assumed that in vocational nystagmus the components of the irritation emanate from the same ganglion cell, whereas, in this instance, two sources can be accepted, namely, a certain nuclear region for the miners' nystagmus and the labyrinth for the vestibular nystagmus. The author is of the opinion that both are combined in a single nervous discharge in the "eye muscle dispatcher."

A Vasomotor Reflex Phenomenon Shown in the Epinephrine-Probe Test by Hot Caloric Irritation of the Labyrinth. O. Muck, Ztschr. f. Hals-, Nasen- u. Ohrenh. **23**:171 (June 10) 1929.

Contrary to the results of the investigations with cold caloric irrigation, it was found that in hot caloric irrigation with water at a temperature of 113 F. (100 to 200 cc.) the vasoconstrictor phenomenon of the white streak in the epinephrine-probe test appeared regularly on the mucous membrane on the other side of the nose. In deaf people, the white streak could not be observed if the deaf ear was irrigated with hot water. Twenty-five people with healthy ears and five people who were totally deaf in one ear were tested. Four or five days before the test, the normal reaction of the epinephrine-probe test must be established. The mucous membrane must not appear irritated or covered with secretion. The lower turbinate must be well developed. The collar around the neck must be loosened. The attention of the patient must be called to the harmlessness of the test. During the use of the first 100 cc. in the ear, the lower turbinate is sprayed with the epinephrine solution only until a plain epinephrine paleness occurs. After the second syringeful, the smooth head of the probe is carried from three to four times, under a moderate pressure, along the mucous membrane, on the right and on the left side. Meanwhile, the nystagmus is observed. From minute to minute, the vasomotor processes are watched. If the test should be repeated, two weeks must elapse before another test is made. In one instance the author states that four weeks should elapse. In hot caloric irritation of one labyrinth, the white streak phenomenon was noticed regularly in the nose on the opposite side, namely, on that side on which no hot irrigation was employed. The change of the vasomotor (vasodilatatory) reflex phenomenon into the vasoconstrictor phenomenon of the epinephrine probe test is, no doubt, caused by caloric irritation of the labyrinth.

Amberg, Detroit.

Nose

Correction of the Osseous "Crooked" Nose and "Broad" Nose. H. Hermann, Ztschr. f. Hals-, Nasen- u. Ohrenh. **23**:133 (June 10) 1929.

Trendelenburg's method (1889) was improved by J. Joseph; yet Joseph used a saw. The use of the saw is tiring to the surgeon. The periosteum is injured, and edema, even abscesses, may result. The bone débris favors the formation of an abscess. For this and similar reasons, the saw has disappeared from the armamentarium of endonasal surgery. In narrowing the osseous broad nose, the effects of sawing are especially disagreeable, because, according to Joseph, not only the line from the apertura piriformis to the inner wall of the orbit is followed by the saw, but also the bridge of the nose on both sides. If one saws too far backward, the tear duct may be torn. If one saws too far forward, an ugly terrace formation develops on the side of the nose. Two years ago, the author devised a chisel which avoids the disadvantages of the methods of Trendelenburg and Joseph. The chisel has a narrow, tapering cutting edge. On the outside, which points outward during the operation, a guard is attached at right angles to the chisel. After an incision has been made at the aperture and the periosteum has

been elevated, the chisel is introduced in the same way as the saw of Joseph. The handle is held by the right hand. The index finger of the left hand controls the progress by touch on the skin. An assistant employs the hammer. The guard allows the chisel to remain in the bone and prevents it from penetrating the soft parts to the outside or to the inside. Swelling of the periosteum is much less pronounced and the period of after-treatment much shorter. An illustration depicting the result of an operation on a crooked nose shows only a slight swelling at the root of the nose, ten days after the operation; in an operation with the saw, a swelling may be present even after six weeks. It is advisable to precede the operation by a high submucous resection of the septum according to Killian. This obviates the after-treatment with special apparatus. It is also advisable to compress the whole region of the root of the nose firmly with tampons immediately after the transposition of the bone, in order to avoid subcutaneous bleeding as much as possible. Hereby also, the time of after-treatment is shortened. Joseph recommends the removal of a wedgelike piece of bone on both sides in the pronounced broad nose; in this operation also the chisel is preferable to the saw. The chisel, like the saw, requires thorough use on the cadaver before being used on the living. This rule applies even in the case of trained surgeons.

Miscellaneous

TONSILLAR TUMORS AND ROENTGENIZATION. MATHAEUS CRISTOFORIDIS, Ztschr. f. Hals-, Nasen- u. Ohrenh. **22**:554 (Feb. 16) 1929.

Benign tumors of the tonsils are rare (Albrecht). Of the malign tumors, two kinds develop on the tonsil: carcinoma of the mucous membrane which covers the tonsil, and sarcoma of the tonsil proper. Sarcomas are somewhat more frequent than carcinomas. Mostly, lymphosarcomas are found. Sarcomas form voluminous tumors that extend, sometimes, more along the surface. They grow with a broad base and are pinkish, knotty and soft, with a glassy surface. They appear like hypertrophies, but they have yellowish-gray border zones and show irregular ulceration. The glands of the neck are swollen. Under the microscope, a mass of lymphocytes is noticed in reticular meshes, but the formation of follicles with germ centers is missing. The negative blood picture excludes similar leukemic growths, while the absence of a tumor of the spleen and of swollen lymph glands exclude pseudoleukemic hypertrophies. Kundrat looks on the disease as a lymphosarcomatosis, while Ceelen and Rabinowitzch consider it hemablastoma, related to the malign lymphoma, and Cohnheim's pseudoleukemia, with general hyperplasias of the lymph glands and a hypolymphemic blood picture. Indeed, the surprisingly benign course found at times and the occasional inclination toward spontaneous involution point to a systemic disease of the lymph apparatus, as also do the involution on treatment by arsenic and the quick effect of roentgenization. All sarcomas are large, knotty tumors, while carcinomas are fungoid ulcers of solid consistency; they are most often pavement epithelium carcinomas. In sarcoma, the outer glands are frequently not swollen; in carcinoma, the deep glands of the neck are involved at an early stage. Rarely, cylindric cell carcinomas and adenocarcinomas are found, also the rather benign basal cell carcinomas, which do not show metastases. Coenen and others, however, deny the existence of these. The passing food and secretions create ulcerations and putrefaction. The increasing difficulty in swallowing, pain, trismus, putrefying processes and secondary catarrh of the stomach lead quickly to great cachexia and death through inanition. The diagnosis is easy. In making a diagnosis, peritonsillar abscesses and ulcerated anginas which can be taken for secondarily inflamed and ulcerated tumors, especially sarcomas, must be excluded. Fluctuation or an exploratory puncture, the presence of fever, etc., serve to establish a differential diagnosis. Of the chronic inflammatory processes, syphilis must be considered on account of the hard and partly ulcerated infiltration and the pronounced swelling of the glands of the neck. The Wassermann reaction, and frequently the macroscopic appearance of the ulcer, facilitate the diagnosis. A fatty base

and a not much raised, sharply defined border are characteristic for tertiary syphilis, while a greasy, putrid ground, a raised wall and cauliflower-like, solid borders identify the carcinoma. The sarcoma is discernible in a pronounced formation of tumor in the tissue surrounding the irregularly shaped deep ulcer. The tuberculous diseases of the throat lead most often to flat infiltrations and ulcers, and rarely to large, tumor-like tuberculomas. In case of doubt, an exploratory excision and histologic examination are necessary. Also, actinomycosis may appear like a tumor, but, then, typical foci of pus and fistulas are present, as a rule. The prognosis of pedunculated sarcoma of the tonsils is comparatively favorable, because this growth can frequently be removed radically, or it reacts to irradiation favorably. The prognosis is almost always bad in carcinoma of the tonsils. Therapeutically, surgical treatment and roentgenization must be mentioned. A carcinoma or a sarcoma can be operated on by way of the mouth only if its extent is easily visible with the mouth wide open. If a carcinoma has grown into the base of the tongue, into the lateral wall of the throat or toward the larynx, the operation by way of the mouth is no longer possible. Then, the methods of Sedillot, von Langenbeck or Kocher come into the question. The results are not encouraging. Schumacher reported twenty-two inoperable tumors of the tonsil among fifty-three patients. The duration of the disease from the beginning to the end averaged ten months. Of thirty-one patients of Schumacher, on whom radical operations were performed, some died on the first, sixth, seventh, eleventh, thirteenth and fourteenth days, respectively. The mortality rate was 22.6 per cent, while in Czerny's cases it was 30.7 per cent. The duration of the disease in those who survived the operation was seventeen and a third months. The literature reports a permanent cure after operation in isolated instances. Honsell reported the case of a patient with sarcoma of the tonsil who lived five years after the operation, and that of a patient with tonsillar carcinoma who also lived five years after the operation. Schumacher reported only two patients cured of twenty-four who were operated on. Today the purely surgical procedure is applied to only a few patients, because the suffering of the patients can also be alleviated conservatively. The general condition must be considered; for instance, bronchitis, emphysema, arteriosclerosis and old age, which are contraindications. Concerning irradiation, it must be stated that an epithelioma is the more sensitive to the rays, the larger the number of the cells in the karyokinetic state. Tumors that are not sensitive can become more sensitive during treatment.

The results in carcinoma must be distinguished from those in sarcoma. Carcinoma: Del Bueno Pietro, 1925, irradiated an inoperable epithelioma of the left tonsil for fifty-one minutes at a 40 cm. tumor-anticathode distance, with a 1 mm. copper filter, from the mouth. After four weeks, the patient reported, the tumor and the glands had disappeared. After six months, Pietro could see only a fine scar on the left palate and did not find any gland. This author recommended, as have others, a prolonged irradiation in order to overcome a possible temporary resistance to the rays. Each tumor has its individuality which is as yet unknown; this is probably dependent on the general constitution. Bertolotti produced a cure in an inoperable case by the combination of radium and roentgen treatment. Heimann observed a roentgen cure for half a year. Molyneux produced a cure of eight years' duration in an inoperable case with radium. Baldenweck and G. Paret treated a patient with pavement epithelium carcinoma with many irradiations from the inside and from the outside. The patients remained free from recurrence for three years. Killian, Denker and von Hinsberg asserted that improvements are only temporary. Nevertheless, irradiation frees the patients from their complaints and allows them to return to their work. It is different with sarcoma. Especially in lymphosarcoma and round cell sarcoma, roentgenization is so much superior to operation that it is the method of choice. Combined roentgen and radium therapy is recommended, with series of treatments at intervals of from two to four months. This treatment is especially adapted for after-treatment following surgical intervention. In the roentgen institution of the university surgical clinic in Leipzig, twenty-seven

tumors of the tonsil were treated in the period from 1919 to 1927, of which fifteen were sarcoma. Of the technic, the following may be mentioned: 0.5 zinc plus 3 aluminum was mostly used, at a distance of from 23 to 30 cm. between target and skin, potential 160 kilovolts, current 4 ma. from 60 to 100 per cent of an erythema dose of rays was applied to both sides of the neck, oral cavity and cheeks. In carcinoma, the average duration of life from the beginning of treatment was six months. In sarcoma, the results were better: The average duration of life from the beginning of irradiation was about eighteen and a half months, which surpassed the duration following surgical treatment by eleven and a half months. In one case of sarcoma, the patient was free from recurrence after fifty-nine months. The prognosis, as mentioned before, is unfavorable in any case. Under the treatment with needles filled with radium-salts, or emanation, recurrences frequently occur after several months.

Clinical and Roentgenologic Observations Concerning Anomalous Processes of Ossification of the Human Hyoid Bone Apparatus. Hermann Barth, Ztschr. f. Hals-, Nasen- u. Ohrenh. **23**:9 (March 23) 1929.

Contrary to the condition in mammals, in which this part of the second bronchial arch has become cartilaginous and then ossified almost completely, Reichert's cartilage in man is changed in its middle part into a fibrous formation, the ligamentum stylohyoideum. According to von Eicken, many observations make one believe that originally the osseous nuclei were in this ligament. Later, abnormal bone may develop therefrom. The rest of the hyoid bone apparatus, the processus styloideus and the little hyoid bone each develop from one osseous nucleus. The processus styloideus is, in the beginning, connected with the temporal bone and the tympanohyale only by connective tissue, and the osseous connection takes place only in the middle years of life. Abnormal processes of ossification may originate from each part of the hyoid bone apparatus. The styloid process can be lengthened. If these foci of ossification combine, distentions and inflexions can develop which can plainly be seen in the roentgen picture. The prolonged styloid process is of practical importance; it may enter the palatine arches or the tonsils. Difficulties during tonsillectomy and annoying throat difficulties may arise. Harburger found about fifty publications concerning the subject. The cause of the complaint is frequently not recognized. La Motte reported that a patient had consulted twenty-nine physicians during eight years without having received a correct diagnosis. The author examined 500 patients in the policlinic, all more than 10 years old. Forty-two times a long styloid process was found, namely, in 8.4 per cent (12.8 per cent of these in males, 5.7 per cent in females). The anomaly may occur comparatively early between the twentieth and thirtieth years. These processes of ossification rarely cause pharyngeal sensations, namely, when a rather pronounced medial deviation and an osseous fixation with the skull exist (von Eicken). The patient complains of strictly localized pain when he swallows. Palpation and the roentgen picture confirm the diagnosis. Also, excessive salivation, earache, even temporary deafness have been observed. In singers, the more active motions of the throat may cause complaints. Palpation of the palatine arches is carried out with counterpressure below the angle of the jaw. In taking the roentgen picture, the head must be bent backward so that the angle between the mandible and the spine becomes large. The tip of the prolonged styloid process should be removed according to Rethi's method. Since 1926, the lower end of the styloid process has been removed in five patients, in von Eicken's clinic, and in two in his private practice.

Morphology of Jacobson's Organ. T. Milstein, Ztschr. f. Hals-, Nasen- u. Ohrenh. **23**:18 (March 23) 1929.

Jacobson discovered the organ in question in 1811. He thought that it served to moisten the oral cavity. Currier thought that it served to discriminate between

useful and noxious food. The author wanted to learn the function and importance of Jacobson's organ by means of anatomic and histologic investigations in the mouse, guinea-pig, rabbit, dog and cat. He thinks that the structure of the organ appears to indicate an olfactory function; otherwise, the presence of specific smelling epithelium identical with that in the olfactory region, which is connected with the olfactory nerve, cannot be understood. Michalovicz and Koelliker have shown that, in man, Jacobson's organ is in the embryonic stage. This is explained by the relative lack of necessity of the organ in man, who uses other organs of sense after he has acquired the upright posture. A similar observation is true of the monkey. The complete atrophy of the organ, found at times in man, can be explained by its unfavorable anatomic location, in which it is greatly exposed to outer noxious influences, for instance, cold air, dust, microbes, etc.

CHANGES CAUSED BY FOREIGN BODIES, WHICH MAY SIMULATE TUBERCULOSIS. A. ESCH, Ztschr. f. Hals-, Nasen- u. Ohrenh. **23**:29 (March 23) 1929.

The author reports two cases in point. A cotton plug was removed from the left antrum of a woman, aged 44. It had been in the antrum for ten years. A Caldwell-Luc operation was performed, leading to a cure. The other patient, a man, aged 44, had been operated on a year previously for a suppurating dental cyst. The patient stated that the cyst was packed for several months and that it had healed, but that a purulent discharge developed in the nose, which still persisted. A Caldwell-Luc operation was performed. A cure resulted. In both cases, the effects of foreign bodies and of an infection could be observed. The thin mucous membrane was changed into a dense cicatricial membrane from 2 to 3 mm. thick, which was closely adherent to the bone. These general diffuse changes must be attributed to the infectious inflammation which was continued and enhanced by the effect of the foreign body. Generally, cicatricial changes are not so prominent in inflammations. The foreign bodies, here small cotton fibers, are not resorbed. They lead to changes of the mucous membrane as they do in other parts of the body. Large giant cells attached themselves to the foreign bodies. In the contiguous area, nodules of epithelioid cells had formed. Lymphocytes were found in these nodules and around them. In the first case, nodules were found which could not be differentiated from epithelioid cell tubercles. Nodules of this kind, consisting of epithelioid cells, have been observed in the peritoneum, if small particles of tissue which cannot be resolved easily get into the abdominal cavity, for instance, cholesterol and the contents of broken ovarian or dermoid cysts. The nodules always consist of epithelioid cells; they do not contain any giant cells and do not show any caseous degeneration. Also, in anal fistulas, the foreign body formations are found, on account of the effects of the feces. The diagnosis is important from the standpoint of therapy, but it may be difficult to establish, because there is no morphologic difference and because the tubercle bacillus may be present but not demonstrable. In the author's case, the morphologic picture would not have allowed him to make a differential diagnosis between tuberculosis and a foreign body formation, if he had not found the foreign body formations in the other half of the suspicious tissue in the control investigations.

INFECTIONS WITH GAS-FORMING MICROBES. MARGARETE STEINBACH, Ztschr. f. Hals-, Nasen- u. Ohrenh. **23**:55 (March 23) 1929.

Anaerobic gas-forming microbes cause grave infections of wounds. Eugen Fraenkel cleared up the etiology by finding *Bacillus phlegmonis-emphysematosae*. Welch cultured his *Bacillus capsulatus-aerogenes*, which is identical with that of Fraenkel. Wound infections that are accompanied by the formation of gas must be differentiated into two classes, namely, those caused by specific anaerobes and those caused by a mixed infection of bacteria, such as staphylococci, streptococci, colon bacilli, proteus bacilli and anaërobic bacilli that are not pathologic.

Both classes of wound infections show typical clinical and pathologic differences. The one is the gas gangrene, gas phlegmon, malign edema or gangrene foudroyante; the other, the gas-containing phlegmon or gas abscess. Gas gangrene can be caused by various microbes, by those which cause putrefaction and by those which do not. The Welch-Fraenkel bacillus belongs to the first group; a short, thick, motionless, anaerobic bacillus with rounded edges, absolutely gram-positive, which is found in the soil and dungholes and in the intestines.

The formation of spores has been observed rarely. The bacillus of malign edema shows motility and formation of spores. These two are the most dangerous of the microbes. Germs of putrefaction alone may cause only occasionally a progressive phlegmon. According to A. Bier, the gas phlegmon is almost always a disease of the muscles; yet it is found also in the brain. According to H. Coenen, the differential diagnosis between gas-containing phlegmon and gas phlegmon and gas gangrene is as follows:

Gas-containing phlegmon	Gas phlegmon and gas gangrene
ETIOLOGY	
Gas-containing phlegmon presents a mixed infection with staphylococci, streptococci, the colon bacillus, the proteus bacillus, the typhoid bacillus, the pseudodiphtheria bacillus, anaerobic bacilli not pathologic for animals, from the group of the bacilli causing putrefaction and butyric bacilli.	Gas phlegmon and gas gangrene show the specific microbes of gangrene, Fraenkel's gas bacillus, the bacillus of malign edema, Ghon-Sach's bacillus and Aschoff's bacillus.
PATHOLOGIC ANATOMY	
Gas-containing phlegmon shows limited putrefaction and putrid decomposition of the tissue in the inflamed wound.	Gas phlegmon and gas gangrene show progressive gassy decomposition in the muscle without inflammatory reaction and without suppuration.
GAS	
Gas-containing phlegmon is marked by circumscribed accumulation of gas in the region of the wound or subcutaneous tissue with sharp outlines (roentgen picture).	Gas phlegmon and gas gangrene are marked by diffuse and streaky progress of the gas in the muscles and under the skin, far beyond the wound (roentgen picture).
WOUND SECRETION	
Gas-containing phlegmon has pus mixed with gas bubbles or brownish putrid fluid, rich in cells.	Gas phlegmon and gas gangrene have no signs of inflammation, no redness; in the beginning, white, edematous skin; later, brown or blue discoloration; cushion-like swelling of the skin, fast propagation; sudden onset of pain, distal from the wound; on incision, no bleeding of the muscle showing further progress.
GENERAL CONDITION	
Gas-containing phlegmon is represented in septic symtoms, dry tongue delirium, unrest and fever.	Gas phlegmon and gas gangrene are without septic symptoms; the general observations are moist tongue; sallow face; clear sensorium; rarely euphoria; very much accelerated pulse; respiratio magna; absence of unrest; fever not constant.

PROPAGATION

Gas-containing phlegmon is propagated in the interstitial tissue of the muscle bundles.	Gas phlegmon and gas gangrene are propagated in the muscle itself, in the fibrillae.

COURSE

The course is generally favorable.	The course is mostly unfavorable.

THERAPY.

Incision.	Amputation; exarticulation.

A case in point was observed in the ear, nose and throat clinic of the Charité. A man, aged 43, seen on Nov. 30, 1926, complained of pain in the right part of the upper jaw. He was feverish. The teeth were carious, especially in the right upper maxilla. The face, especially the right temporal region, was swollen. Here, crackling on palpation and a tympanic sound on percussion were noticed. The lateral and posterior wall of the maxillary antrum were removed. The infiltration reached from the canine fossa to the retromaxillary fossa, and from there, under the zygomatic process, to the temporal fossa. Counter-incisions were made in the temporal region. The temporal muscle was completely putrefied and gassy. The patient died on Dec. 4, 1928, with septic symptoms, clouded sensorium, high temperature and delirium. Colon bacilli, streptococci and staphylococci were present in the muscle. Necropsy showed a putrefying phlegmon originating from a granuloma of the second right upper premolar tooth extending to the temporal muscle. Suppuration of both cavernous sinuses, more pronounced on the left side, was found. Septic thrombophlebitis existed in the field of operation. Septicopyemia with septic emboli in both lungs was present, also subpleural abscesses, septic hemorrhagic nephritis, a soft septic spleen, hemosiderosis of the spleen and liver, etc. A detailed description of the conditions in the heart, lungs, liver, kidneys, suprarenal glands, pancreas, testes, prostatic, thyroid gland and spleen follows. The brain showed only moderate congestion. Contrary to the observations in other cases, the process in this instance developed spontaneously and not after an incision, in a wound or after infection, delivery, etc. In this patient, the microbes, including colon bacilli, found entrance into the body through the diseased root of the upper second premolar tooth. The patient had felt entirely well until the day when the swelling developed in the temporal region.

AMBERG, Detroit.

Book Reviews

REVIEW OF THE NOSE, THROAT AND EAR AND THEIR DISEASES. IN ORIGINAL CONTRIBUTIONS BY AMERICAN AND EUROPEAN AUTHORS. Edited by CHEVALIER L. JACKSON and GEORGE M. COATES. Pp. 1177, with 684 illustrations. Philadelphia and London: W. B. Saunders & Company, 1929.

This encylopedic book covers practically all the ear, nose and throat conditions. As the editors themselves say: "In systematic work by many authors, one does not expect to find the degree of correctness usual in a book written entirely by one author." Some of the subjects are discussed sketchily, while others are treated completely, the chapters here attaining the proportions of monographs. Among the more comprehensive chapters are those on the anatomy of the nose, the anatomy of the ear, conditions of the external ear, diseases of the maxillary sinus, diagnosis of intracranial complications from aural suppurations, functional testing of hearing, common diseases of the esophagus and, last but not least, peroral endoscopy, especially bronchoscopy. A rather unique feature, and one that is omitted from most books on the subject of the throat, is the chapter on tonsilloscopy and its recent revelations. Whether the expectations of this type of examination will be realized by laryngologists is still a moot question.

One of the most essential features of a work of this kind is a suitable bibliography of the various articles. It is important, particularly to the student and research worker, to be able to pursue investigations further by means of references to the literature. Many of these articles have excellent bibliographies appended, but, unfortunately, some of them give absolutely no reference.

Beginning with the discussion of the nose and accessory sinuses, their anatomy, inflammatory diseases, neoplasms, etc., the work proceeds in the second part to a consideration of the pharynx and nasopharynx; the third part is devoted to the ear; the fourth to diseases of the larynx; the fifth to peroral endoscopy, while the sixth and concluding portion deals with diseases of the hypopharynx, esophagus and tracheobronchial tree.

The book is profusely illustrated and systematically arranged. The type is clear and the headings distinct, so that the subject matter can be easily perused. Altogether it appeals to the reviewer as an excellent compilation of medical literature and the best of its kind that has thus far appeared in the English language. In some of the recent German systems, the text is, of course, much more comprehensive and much more detailed and possibly serves as a better aid in research work. To have covered as much ground as the editors have in a single volume is an achievement. This work will be a great aid to practitioners and to teachers of otolaryngology.

OTOSCLEROSIS: A RÉSUMÉ OF THE LITERATURE TO JULY, 1928, COMPILED UNDER THE DIRECTION OF THE COMMITTEE ON OTOSCLEROSIS, OF THE AMERICAN OTOLOGICAL SOCIETY. Price, $15. Pp. 706. New York: Paul P. Hoeber, 1929.

This is a comprehensive résumé of the literature on otosclerosis published in two volumes. The material is arranged under six sections as follows:

Section 1—Pathology.
- Chapter 1 Stapes Ankylosis.
- Chapters 2, 3, 4 Changes in the Labyrinth Capsule.

Section 2—Etiology.
- Chapter 5 Heredity as an Etiologic Factor.
- Chapter 6 Congenital Conditions in the Labyrinth Capsule.
- Chapter 7 Influence of Local Conditions.
- Chapter 8 Influence of General Conditions.

Section 3—Symptoms and Diagnosis.
Chapter 9 General Symptoms.
Chapter 10 Hearing Tests.
Chapter 11 Illustrative Cases.

Section 4—Treatment.
Chapter 12 Local Surgical Measures.
Chapter 13 Local Nonoperative Measures.

The work includes a complete bibliography, together with a complete index of personal names and an index of subjects.

This compilation fills a long felt need. The abstracting is excellently done. No critical comments are made. The aim is to cover all the facts that have been brought out in the voluminous literature on this most interesting subject. The value of having such a complete reference work on otosclerosis is incomparable. It is a work which every practicing otologist will want to own. The literature of every phase of the problems of otosclerosis is comprehensively covered, and the volume will do much in popularizing knowledge of this baffling condition.

The committee on otosclerosis of the American Otological Society is to be congratulated on the successful completion of this important undertaking.

Directory of Otolaryngologic and Ophthalmologic Societies *

NATIONAL

AMERICAN MEDICAL ASSOCIATION, SECTION ON LARYNGOLOGY, OTOLOGY AND RHINOLOGY

Chairman: Dr. William V. Mullin, Cleveland Clinic, Cleveland.
Secretary: Dr. Gabriel Tucker, Bronchoscopic Clinic, University Hospital, Philadelphia.
Place: Detroit. Time: 1930.

AMERICAN BRONCHOSCOPIC SOCIETY

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Secretary: Dr. George M. Coates, 1721 Pine St., Philadelphia.

AMERICAN LARYNGOLOGICAL, RHINOLOGICAL AND OTOLOGICAL SOCIETY

President: Dr. Ross Hall Skillern, 1811 Spruce St., Philadelphia.
Secretary: Dr. R. L. Loughran, 33 E. 63d St., New York.
Place: Atlantic City, N. J. Time: May, 1930.

AMERICAN OTOLOGICAL SOCIETY

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AMERICAN ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

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Executive Secretary: Dr. William P. Wherry, Medical Arts Bldg., Omaha.
Place: Atlantic City, N. J. Time: Oct. 21-25, 1929.

LOCAL

Los Angeles County Medical Society, Section of Ophthalmology and Otolaryngology

President: Dr. Harold S. Muckleston, 6422 Hollywood Blvd., Los Angeles.
Secretary-Treasurer: Dr. J. Frank Friesen, 1208 Roosevelt Bldg., Los Angeles.
Place: California Hospital, assembly room. Time: 8 p. m., first Monday of each month.

* Secretaries of societies are requested to furnish the information necessary to make this list complete and to keep it up to date.

THE COLORADO OTO-LARYNGOLOGICAL SOCIETY

President: Dr. Frank L. Dennis, Ferguson Bldg., Colorado Springs.
Secretary: Dr. Rex L. Murphy, Metropolitan Bldg., Denver.
Place: Assembly Room of Metropolitan Bldg. Time: First Saturday of each month from October to May.

MEDICAL SOCIETY OF THE DISTRICT OF COLUMBIA, SECTION ON OPHTHALMOLOGY AND OTO-LARYNGOLOGY

Chairman: Dr. Louis S. Greene, 1710 Rhode Island Ave. N. W., Washington.
Secretary: Dr. R. E. Gookin, Medical Science Bldg., Washington.
Place: 1718 M St. N. W. Time: 8 p. m., third Friday of each month.

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President: Dr. H. F. McDuffie, 45 Edgewood Ave., Atlanta, Ga.
Secretary: Dr. Leon E. Brawner, 157 Forrest Ave. N. E., Atlanta, Ga.
Place: Academy of Medicine, 38 Prescott St. N. E. Time: 8 p. m., last Thursday of each month.

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President: Dr. Samuel Salinger, 25 E. Washington St., Chicago.
Secretary-Treasurer: Dr. Austin A. Hayden, 25 E. Washington St., Chicago.
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INDIANA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

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Secretary: Dr. Robert J. Masters, 601 Hume-Mansur Bldg., Indianapolis.
Place: French Lick Springs Hotel. Time: Dec. 12-13, 1929.

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Secretary: Dr. Moses L. Breitstein, 1212 Eutaw Pl., Baltimore.
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Place: 103d St. and 5th Ave. Time: Second Friday of each month from October to May.

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Place: Rochester Medical Association, 13 Prince St. Time: 8 p. m., third Monday of each month from October to May.

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